U. S. DEPARTMENT OF AGRICULTURE

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A. W. HARRIS, DIRECTOR

EXPERIMENT STATION

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A. W. HARRIS, DIRECTOR

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EXPERIMENT STATION RECORD.

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EDITORIAL NOTES.

In view of the facts that the needs of the Department in its relation to the experiment station enterprise, seem to demand that the Director of this Office shall devote his entire time and energy to official duties, and that Mr. W. O. Atwater did not feel that he ought to relinquish his opportunities for original research, he has resigned the directorship of the Office. His services will, however, be retained as a general counselor in scientific matters, and the fruits of his wide experience and study with regard to European investigations in agricultural science will be made available. He will be a regular contributor to the record of abstracts of European publications, and in certain special lines he expects to be able to furnish résumés of past and current inquiries.

Under the new organization of the Office Mr. A. W. Harris, formerly Assistant Director, becomes Director, and Mr. A. C. True, formerly First Assistant Editor, becomes Assistant Director. The editorial and clerical force of the Office is to be somewhat enlarged, and it is hoped that in the coming fiscal year much work will be accomplished which will be of benefit to the stations and to farmers.

The agricultural experiment station now located at the Agricultural Institute of the University of Göttingen, Germany, was established at Weende near Göttingen in 1857 and removed to its present location in 1874.

Dr. Wilhelm Henneberg was director of the station from its foundation until his death in November, 1890. During his connection with the station he also continued to be editor of the *Journal für Landwirthschaft*, which he had established in 1853, and from 1865 he was professor of agricultural chemistry in the University of Göttingen. In addition to his contributions to the theory of animal nutrition, Henneberg gave much attention to other lines of work, as plant nutrition in the earlier part of his career, and, later, human physiology.

The list of his published works includes over one hundred and seventy numbers. These cover a wide range of subjects, most of them related to agricultural and physiological chemistry. Professor Henneberg counted among his pupils many of the prominent agricultural chemists in Europe. He was a member of not less than seventeen scientific associations and societies in Germany and other countries. In 1889 the German Government conferred upon him the title of privy councilor.

The death of Professor Henneberg has been the occasion of several reviews* of his life work and of the history and development of the station where he labored so successfully for more than 30 years, and which under his charge contributed so largely to the development of the modern science of animal nutrition. Next to Liebig, Henneberg and v. Wolff rank as pioneer investigators of the nutrition of farm animals.

The methods of analyzing feeding stuffs, of testing their digestibility, and of experimenting upon their nutritive values, the currently accepted doctrines of animal nutrition, and the feeding standards which our stations follow in their work and in their teachings, are taken for the most part from European and especially from German sources. No station has done more to acquire accurate knowledge in these directions than the one of which Professor Henneberg was director. Its history is of interest, not only on this account, but as illustrative of the wisdom of specialization, of the practical value of abstract research, and of the time, labor, and expense that are necessary for obtaining the most useful results.

At the time of the establishment of the station the science of animal nutrition was in the earlier and cruder phase of its development. Such pioneer investigators as Lawes and Gilbert in England, Boussingault in France, and, preëminently, Liebig in Germany had laid out the line of future progress. Liebig had drawn the broad distinctions betwen the nutritive ingredients of food and their functions. Bischoff, Pettenkofer, and Voit were elaborating the principles of nutrition of carnivorous animals. But the methods of analysis of foods and feeding stuffs were still very incomplete. In estimating the nutritive value of feeding stuffs, Thaer's theory of hay values, which rated given quantities by weight, of the different kinds of fodder, as equal to 100 parts by weight of hay, and Boussingault's equivalents, which were based on the nitrogen content of feeding stuffs, still prevailed. By carefully conducted feeding experiments, Henneberg pointed out the errors in Thaer's method of estimating the value of feeding stuffs and showed the theory to be untenable. In its place he proposed a theory based on the chemical composition of the materials. The fundamental importance of this new doctrine is set forth by Prof. E. v. Wolff.

"The year 1860 is more especially to be regarded as the beginning of a new period in the development of the science of animal nutrition, since

*Jour. f. Landw., 38, No. 3; Landw. Vers. Stat., 39, p. 1.

in this year, almost simultaneously with the works of Bischoff and Voit, appeared the first number of the *Beiträge zur Begründung einer rationellen Fütterung der Wiederkäuer*, by Henneberg and Stohmann. For the first time the solid and liquid materials excreted by herbivora under well-defined circumstances had been carefully studied in numerous experiments, with reference to quantity and chemical composition. These experiments threw much light on the food requirements of mature oxen, and showed in general the manner in which important questions in animal nutrition must be solved."

The specific questions proposed for study by Henneberg early in his work are stated by him as follows:

(1) What are the actually nutritive ingredients in different feeding stuffs and in what proportions do they occur in each?

(2) In what proportions must their nutritive ingredients be fed in order to produce from a minimum of food the maximum of flesh (lean) or fat, or both?

For the solution of these questions, Henneberg, with his assistants and colaborers at Weende, among whom have been Stohmann, Gustav Kühn, Rautenberg, Maercker, H. Schultze, E. Schulze, Fleischer, K. Müller, Kern, Wattenberg, Th. Pfeiffer, and F. Lehmann, undertook investigations upon the methods of analysis of feeding stuffs, digestibility of the ingredients, and the nutritive effects as shown by feeding experiments.

The methods of analysis of feeding stuffs known as the Weende or Henneberg-Stohmann methods, which with minor modifications are in common use in Europe and America to-day, were elaborated and soon found general recognition. These methods were applied not only to determining the percentages of cellulose, fat, protein, and nitrogen-free extract in feeding stuffs, but also in connection with feeding experiments, to determining the amount of each of these ingredients actually digested by animals. Henneberg reasoned that if the feces as well as the food given, were subjected to analysis, the difference between the amount of each ingredient in the food and in the feces would represent the amounts of crude cellulose, crude fat, crude protein, and nitrogen-free extract which had been digested, an idea which at that time (1859) was new. Experiments were begun on the digestion by cattle of various feeding stuffs when fed alone or in combination with large or small quantities of easily digestible materials, and these were after a time taken up by other experimenters. Early in these investigations it was discovered that the crude fiber of the coarser fodders (hay, straw, etc.), which up to this time had been considered as indigestible, was to a large extent (one half or more) dissolved in the intestinal canal, and that the nitrogen-free extract, which had been supposed to be wholly digested, was in the case of coarser fodders, scarcely more digestible than the crude fiber. It was found that in the process of digestion crude cellulose yields a substance having the formula of pure cellulose

or starch in solution. A third discovery was with regard to a depression in digestibility sometimes noticed.

Henneberg early reached the conclusion that "without the aid of respiration experiments the laws underlying the formation of flesh and fat can not be worked out conclusively." In 1862 means were secured from the Government of Hanover for erecting a respiration apparatus on the plan of that used by Pettenkofer in Munich in investigations on carnivorous animals. For many years this was the only apparatus of the kind in use in agricultural investigations. Unexpected and serious difficulties were met with in the use of an apparatus sufficiently large for the purpose, and years of patient labor were required to overcome these. At length, however, it became possible to present a clear and complete representation of the transformation of nitrogen within the body, and to work out the first metabolic proportions for farm animals. The results of the experiments of Pettenkofer and Voit on carnivorous animals were applied by Henneberg and his assistants to ruminants, and happily for the progress of science the results obtained in Munich and in Weende confirmed each other. The most important facts brought out for ruminants were as follows:

An increased consumption of protein in the food is accompanied by an increased breaking down of the albuminoid materials of the body, *i. e.* increased nitrogen metabolism.

The amount of protein in the food regulates the nitrogen metabolism but not the nitrogen storage, that is to say, the amount of protein transformed but not the amount of lean flesh accumulated in the body. It is a mistake, therefore, to assume that such nitrogenous feeding stuffs as bean meal or rape cake will in all cases increase the production of lean flesh or other nitrogenous materials of the body to a degree that will be pecuniarily profitable.

The addition of non-nitrogenous ingredients to the food without changing the protein may cause an increased formation of flesh (lean). These materials may, under some conditions, produce as good results as the addition of a like amount of protein to the food.

The formation of fat in the body of neat cattle probably takes place irrespective of the presence or absence of fat in the food. The exact influence of protein on the formation of fat remains to be determined,

Under otherwise corresponding circumstances, the process of respiration in different-sized animals is dependent on the surface exposed, *i. e.*, the area of the surface of the body.

In 1879, studies were begun as to the effect on the total metabolism in grown animals of adding different and increased proportions of the several ingredients of food to a maintenance ration. The first series of these experiments was with regard to the albuminoids. This was worked out according to the original plan, but could not be published until recently (see Experiment Station Record, vol. II, p. 462). Similar experiments with regard to the carbohydrates and fats were carried out in 1882, but the means for controlling the results and extending the

experiments were not at hand. Additional funds for this purpose were at length secured, and in 1889 the experiments were again taken up.

The results of 3 years of experimenting at the station leave no room for doubt that in the process of flesh formation a highly digestible cellulose is not essentially different in its action from the easily soluble carbohydrates. The results of more recent experiments, extending over a shorter period, indicate further that in the laying on of fat digestible cellulose is very little, if at all, inferior in its action to other carbohydrates.

To recapitulate, the work of the experiment station at Weende-Göttingen has been principally in three directions: First, the overthrowing of the theory of hay-values, the setting up in its place of a theory based on chemical composition, and the working out of the Weende methods of analysis. Second, the recognition of the fact that to give these analyses their full value, they must be accompanied by coefficients of digestibility based on trials with animals. The first experiments of importance in this direction were made at Weende. The digestibility was determined for numerous coarse and concentrated feeding stuffs, and the influence of concentrated feeds rich and poor in nitrogen, on the digestibility, was studied. The study of digestibility and depression in digestibility had its origin at Weende. Third, the study of the laws of flesh (lean) and fat formation in herbivora, showing these laws to be in all particulars the same as those laid down by other investigators for carnivorous animals.

The capabilities of the station as now equipped are stated by the present director, Prof. Franz Lehmann, as follows:

"We are now able by the use of an apparatus of inestimable value, to determine within a few grams the amount of fat daily stored in the body by sheep, and the storage of protein perhaps even more accurately. We are therefore in a position to take up and answer numerous questions relating to the feeding of animals."

The work of the immediate future, as outlined by him, is to be of a practical nature. Attention will be given to such questions as that of the advisability of feeding a ration richer in nitrogen than the normal ration usually accepted.

Years have been spent in preparation for the practical work which it is now proposed to undertake, and it is confidently believed by the director that investigations with the respiration apparatus will lead to methods of feeding which will render it possible to "produce at will more lean meat and less fat, and cheaper and better meat."

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Alabama College Station, Bulletin No. 25 (New Series), April, 1891 (pp. 12).

EFFECTS ON BUTTER OF FEEDING COTTON SEED AND COTTON-SEED MEAL, N. T. LUPTON, LL. D.—To test the effects "on the volatile acids, melting point, and specific gravity of the butter produced under their influence," the following rations were fed to a herd of 11 Jersey cows in five periods of 7 days each, the periods being separated by intermediate periods of 1 week each:

Period I. 5 pounds ground oats, 5 pounds bran, 5 pounds corn meal.
Period II. 4 pounds ground oats, 5 pounds bran, 3 pounds cotton-seed meal, 11 pounds silage.
Period III. 4 pounds cotton-seed meal, 4½ pounds silage, 9 pounds cotton-seed hulls.
Period IV. Raw cotton seed and cotton-seed hulls *ad libitum*.
Period V. Cooked cotton seed and cotton-seed hulls *ad libitum*.

The analyses of the feeding stuffs used and the yield and composition of milk and butter in each period are tabulated. These data indicate "a marked falling off in the quantity of milk and an increase in the amount of butter produced during the first three periods." In the fourth and fifth periods there was a decided decrease in the amount of both milk and butter.

From the first to the fourth periods the volatile acids of the butter decreased and the melting point increased, the increase in melting point amounting to about 8° C. In the fifth period there was a slight increase in volatile acids and decrease in melting point. "No change was observable in the color of the butter from feeding cotton seed and cotton-seed meal."

Alabama College Station, Bulletin No. 26 (New Series), April, 1891 (pp. 41).

COMMERCIAL FERTILIZERS, N. T. LUPTON, LL. D.—Tabulated analyses of 343 samples of commercial fertilizers and fertilizing materials, including cotton-seed meal, cotton-seed-hull ashes, tankage, dried blood, bat manure, phosphatic rock, acid phosphate, compost, ground bone, bone ash, muriate of potash, nitrate of soda, and ashes from a coke furnace.

Alabama College Station, Bulletin No. 27 (New Series), May, 1891 (pp. 16).

BLACK RUST OF COTTON, G. F. ATKINSON, PH. B. (plates 2).—This is, in substance, a paper read before the section on botany of the Association of American Agricultural Colleges and Experiment Stations, in November, 1890, and afterwards published in the *Botanical Gazette*, vol. XVI (1891), pp. 61–65. The author calls attention to the confusion existing with reference to the name of this disease, which is not a true rust. His observations indicate that what is popularly known as "black rust of cotton" is of a complex character. "The fungi commonly present and which play an important part in the disease, are *Cercospora gossypina*, Cooke, *Colletotrichum gossypii*, E. A. Southworth, *Macrosporium nigricantium*, Atkinson, a species of *Alternaria*, and a bacterial organism which sometimes produces a characteristic disease of the leaves." The difference between leaf blight and black rust of cotton is pointed out, and the botanical characters of the fungi connected with the latter disease are described and illustrated. The author has observed on dead leaves of cotton a sphæriaceous fungus which he thinks is probably the ascospore stage of *Cercospora gossypina*. The following is taken from his description of *Macrosporium nigricantium* (see also *Botanical Gazette*, vol. (XVI 1891), p. 62):

The hyphæ are dark or olive brown and borne on both sides of the leaf. At the enlargements there is usually a darker band around the center. The hyphæ thus have a nodulose appearance, as in such species as *Macrosporium parasiticum*, Thüm. The spores are olive brown, oblong, constricted in the middle, and stoutly rostrate at one side of the apex. As the young spore develops it is constricted in the middle before the first transverse partition is formed. This is formed in the constricted portion. Later other transverse, longitudinal, and oblique septa are produced. * * * The fertile hyphæ are usually scattered, rarely in clusters of two or three. Measurements: Hyphæ are 0.050 to 0.140^{mm} long by 0.006 to 0.007^{mm} in diameter; conidia, 0.018 to 0.022^{mm} by 0.036 to 0.050^{mm}.

The *Alternaria* is illustrated from a water culture under the microscope. The fertile hyphæ produce concatenate spores. Both the spores and the fertile hyphæ are dark brown in color and when occurring in considerable numbers blacken the leaf.

The bacterial disease is often very widespread, even when no evidences of the other fungi are to be found, but is mentioned here because frequently it is an accompaniment of the black "rust" and contributes materially to the aggravation of the disease. It is first manifested by a watery appearance in definite areolate spots, which are bounded by the veinlets of the leaf. The spots are sometimes very numerous and frequently conjoined; often the disease follows one or more of the main ribs of the leaf, being bounded on each side by an irregularly zigzag line. As the disease ages, the spots become blackish and then light brown, then frequently bordered by a blackish color where the disease has extended somewhat centrifugally. The dead spots in the leaves sometimes break out, leaving many perforations in the leaves with ragged edges, somewhat as results in cotton leaf blight. The disease hastens the falling off of the leaves.

External characters and progress of the disease.—During the entire season (from July to the close of October), of the thousands of leaves, old and young, that I examined,

Cercospora gossypina has been an almost universal accompaniment, and has not been second in point of attack, except perhaps in rare cases. In many cases parallel or immediately succeeding attacks were made by the *Colletotrichum*. The *Macrosporium*, as a rule, follows closely the attack of the *Cercospora*, indeed sometimes seeming to be first to attack. In such cases possibly it attacked the spots diseased by *Cercospora* before the hyphæ and conidia of the latter were developed. The *Alternaria* usually succeeds the *Macrosporium*, though often seeming to be parallel with it. By its clusters of hyphæ and profusely developed concatenate spores in favorable weather the leaf is soon covered with a mass of spores, giving a blackened appearance to the leaves.

Current theories regarding the cause of the disease are discussed. Experiments with reference to its repression will be conducted at the station.

Colorado Station, Bulletin No. 15, April, 1891 (pp. 22).

CODLING MOTH AND GRAPEVINE LEAF HOPPER, C. P. GILLETTE, M. S. (figs. 5).—Compiled notes on the codling moth (*Carpocapsa pomonella*) and the grapevine leaf hopper (*Typhlocyba vitis*), with suggestions as to means for their repression.

Connecticut State Station, Annual Report, 1890 (pp. 207).

REPORTS OF BOARD OF CONTROL, TREASURER, AND DIRECTOR (pp. 3–8).—These include brief statements regarding the work of the station and an exhibit of receipts and expenditures for the fiscal year ending June 30, 1890. One hundred and forty-six distinct brands of fertilizers are known to be on sale in the States. The analyses of these and other manurial substances made at the station in 1890 numbered 310. Analysis fees collected during the fiscal year amounted to $4,221.50. The station has material for reports on examinations of seeds, analyses of potatoes, molasses, maple sirup, vinegar, and butter, and a coöperative experiment on the composition of corn grown in different localities, but lack of funds prevents their immediate publication.

FERTILIZERS (pp. 9–79).—Abstracts from the Connecticut fertilizer law, a list of manufacturers complying with this law, the brands of fertilizers licensed in the State during 1890, analyses of fertilizers, revised explanations concerning the analysis and valuation of fertilizing materials, the trade values of fertilizing ingredients for 1890, and a review of the fertilizer market.

Analyses of fertilizers and waste products.—Analyses are given of 314 samples of fertilizing materials, which include besides branded mixed fertilizers, nitrate of soda, sulphate of ammonia, dried blood, cotton-seed meal, castor pomace, hoof meal, Thomas slag, precipitated phosphate, dissolved boneblack, double sulphate of potash and magnesia, muriate of potash, kainit, bone manures, tankage, home-mixed fertilizers, cotton-hull ashes, unleached wood ashes, limekiln ashes, limestone, wool waste, tank water and settlings from bone and

wool-scouring works, plaster, barnyard manure, rockweed, seaweed, Iceland moss, and pigeon manure.

One sample of cotton-seed meal was found to be "adulterated with rice meal, which is harmless, but reduces the value of the meal either as a food or fertilizer, by $4 or $5 a ton. The color of the meal was rather lighter than pure meal, but the adulteration is not likely to be detected without microscopic or chemical examination."

Concerning the mixed fertilizers it is stated that "in five cases the valuation [of superphosphates] exceeded the cost. Leaving out of account three analyses in which the cost exceeded valuation by considerably more than 50 per cent, the average cost of 62 nitrogenous superphosphates was $33.80 and the average valuation $28.57. The difference is $5.23 and the percentage difference 18.3. * * *

"The average cost of 33 special manures has been $39.18 and the average valuation $32.90. The difference between the cost and valuation has been $6.28 and the percentage difference 19.

"This year the special manures as a class have been higher priced and more concentrated than the other nitrogenous superphosphates, but not, as heretofore, more economical to purchase."

Review of the fertilizer market.—A table is given with explanations, showing the fluctuations in the wholesale prices of nitrogen, potash, and phosphoric acid in a number of standard materials for each month from July, 1887, to December, 1890, and two other tables facilitating the calculation of the cost of nitrogen per pound from the cost of ammonia per unit or per pound of commercial sulphate of ammonia, as given in the market quotations.

In general, nitrogen in blood, azotin, nitrate of soda, and fish scrap have fallen decidedly in price during the year. The nitrogen of sulphate of ammonia has, on the other hand, risen considerably.

Charleston rock is considerably lower, boneblack somewhat lower; bone has remained constant through the year.

Acid phosphate made from South Carolina rock is considerably lower than at the opening of the year.

Muriate of potash, double manure salt, and kainit are quoted about as they have been through the year, but high-grade sulphate is very considerably lower.

REPORT OF MYCOLOGIST, R. THAXTER, PH. D. (pp. 80–113, plates 3, figs. 3).—*Potato scab* (pp. 81–95).—This is a detailed report of observations previously summarized in Bulletin No. 105 of the station (see Experiment Station Record, vol. II, p. 490). The substance of the present article was also presented in a paper read before the section on botany of the Association of American Agricultural Colleges and Experiment Stations, at Champaign, Illinois, November 12, 1890. The topics treated are, Theories of the Origin of Potato Scab, General Characters of the Disease and of the Scab Fungus when Cultivated, Life History of the Scab Fungus, Inoculations Made with the Scab Fungus, A Comparison of "Deep" and "Surface" Scab, and The Botanical Relations of the Scab Fungus. Specimens of potatoes affected with the ordinary deep

scab and with the same form of scab induced by inoculation are illustrated in a plate accompanying the article.

Miscellaneous notes (pp. 95–98).—*Phytophthora infestans* injured the leaves and fruit of tomatoes in 1890 in several parts of Connecticut. Injuries to the leaves by *Cladosporium fulvum*, and to the fruit by *Macrosporium tomato*, Cke., and by *Fusarium lycopersici*, Sacc., are also reported. A destructive epidemic was observed among the tomato worms (*Phlegethontius carolina* and *P. celeus*) infesting a field in the vicinity of New Haven. It was found that this was caused by the fungus "*Empusa grylli*, form *aulicæ*, which is common on hairy caterpillars and has also been found this year on a number of naked cutworm larvæ (*Lithophane*, *Mamestra*, and *Agrotis*). It was found easy to propagate it on young tomato worms, which died after the usual period of incubation (6 to 10 days) with the characteristic symptoms." Another species of *Empusa* was very destructive to the grape leaf hopper (*Typhlocyba vitis*) in a vineyard at Meriden and was also found at New Haven on the cabbage worm (*Pieris rapæ*), on which insect it was successfully bred at the station. "What appears to be the same *Empusa* has kindly been sent from New Jersey by Professor Halsted, on *Pieris* larvæ, and the same fungus is reported to have killed vast numbers of the clover weevil in that locality during the past season."

Peronospora cubensis was observed on cucumbers at South Manchester, Connecticut.

The mildew of lima beans (*Phytophthora phaseoli*), described and illustrated in the report of the station for 1889, page 167 (see Experiment Station Record vol. II, p. 482), was again destructive in 1890, making its appearance in a number of localities in Connecticut. Several varieties of pears of the Japanese strain have shown themselves very susceptible to injury by a rust (*Gymnosporangium globosum*) derived from the red cedar. This rust is also found on apples, quinces, etc., in Connecticut, but does not attack the ordinary varieties of pears.

"A mildew, which appears to be the form described by Peck as *Ramularia rufomaculans* on another member of the same family (*Polygonaceæ*), has been observed in several localities on buckwheat."

A clover rust referred to in the Annual Report of the station for 1889 as caused by *Uromyces striatus*, proves to be *U. trifolii*, Wint., and was very abundant in 1890.

Puccinia rubigo vera, D. C., and *Urocystis occulta*, Rabh., were very common on rye in 1890.

Some results from the application of fungicides (pp. 99–104).—Successful experiments are reported with Bordeaux mixture and ammoniacal carbonate of copper for leaf spot of quince (*Entomosporium maculatum*, Lev.), black rot of grapes, anthracnose of grapes, and strawberry rust; and with Bordeaux mixture for leaf spot of plums and cherries and potato blight. The effect produced by the treatment with Bordeaux mixture for the leaf spot of quinces is strikingly illustrated in two plates

showing treated and untreated quince orchards. Experiments with sulphur for the smut of onions, continued in 1890, were inconclusive.

Fungicides and their application (pp. 104–113).—Suggestions are made with reference to the use of fungicides; spraying apparatus of various kinds is described and illustrated; directions are given for the preparation of Bordeaux mixture and carbonate of copper solution. A combination of a copper wash-boiler, a "Hydronette" force pump, and a Vermorel nozzle, devised by the author and used successfully at the station, is described in detail. "The advantage of this apparatus is that in addition to its cheapness (its total cost is a little over $8), it leaves the force pump free for other uses, when not wanted for spraying, and is also readily made by any one of ordinary intelligence."

PROTEIDS OR ALBUMINOIDS OF THE OAT KERNEL, T. B. OSBORNE, PH. D. (pp. 114–161).—This contains a full description of the author's investigation of the proteids of the oat kernel, allusion to which has been previously made in Experiment Station Record, vol. II, p. 304. The author summarizes the results of previous investigations in this direction as follows:

> The proteids contained in or derived from the oat grain have been specially studied by J. P. Norton, Baron von Bibra, and Dr. W. Kreusler.
>
> Norton* recognized three proteids, viz, (1) *Albumin*, 0.5 to 2.17 per cent, which was taken up from the "epidermis" (after starch had been mechanically removed by elutriation with slightly ammoniacal water) by boiling with acetic acid, and was precipitated by neutralizing the solution. (2) *Casein* (or *avenine*), 15.76 to 17.72 per cent, which was dissolved in the slightly ammoniacal water used in separating starch, and thrown down by acetic acid. (3) *Glutin*, 1.33 to 2.47 per cent, extracted by alcohol and separated from oil by means of ether, and from sugar by water.
>
> Von Bibra† found that no coherent gluten could be got from oat flour by kneading in water. He recognized *albumin*, 1.24 to 1.52 per cent, precipitated by boiling the cold-water extract of the ground oats; *casein*, 0.15 to 0.17 per cent, the body separating from the hot-alcohol extract on cooling; *plant gelatin* (Dumas' *glutin*, Tadder's *gliadin*), 3 to 3.25 per cent, the substance soluble both in hot and cold alcohol; and nitrogenous substance, insoluble in water and alcohol, 11.38 to 14.85 per cent.
>
> Kreusler‡ found *oat gliadin* soluble in weak alcohol and *oat legumin* soluble in very dilute alkali.

The author studied preparations obtained from the extractions of freshly ground oats with hot alcohol of 0.915 specific gravity; with alcohol after previous treatment of oats in separate cases with water, with a 10 per cent solution of sodium chloride, and with water and salt solution successively; with water alone; with a 10 per cent solution of sodium chloride at 15° to 20° C.; with a similar salt solution after previous treatment of the oats with cold alcohol of 0.9 specific gravity; by 0.2 per cent potassium hydrate solution alone, and after previous extraction of the oats with alcohol of 0.9 specific gravity, and with water for 1 hour, and for 24 hours; and with a 10 per cent

* Am. Jour. of Sci. and Arts (second ser.), III, 330 (1845), and ser. v., 22 (1848).

† Die Getreidearten und das Brod, Nürnberg (1860).

‡ Jour. f. prak. Chem, CVII, 17 (1869).

solution of sodium chloride at 65° C. The following summary of the results of these studies is given by the author:

(1) The proteid body removed from fresh-ground oats by direct extraction with weak alcohol, first observed by Norton and by him designated *glutin*, when dehydrated by absolute alcohol and dried over sulphuric acid, is a light-yellowish powder, insoluble in pure water as well as in absolute alcohol, soluble in mixtures of alcohol and water, soluble also in dilute acids and alkalis, and from these solutions thrown down by neutralization. Separated from its solution in alcohol of 60 per cent by evaporating off the alcohol, it forms a yellowish, slimy mass. Its composition is given in the [following] table under I. This substance is remarkable for its considerable content of sulphur, which is exceeded by that of keratin alone among the proteids, and is otherwise equaled only by that recorded in some analyses of serum-albumin.

(2) When the substance described above is heated with dilute alcohol for some time it coagulates and becomes insoluble in that liquid, but without apparent change of composition. II is the average of three accordant analyses of this coagulated form of the alcohol-soluble proteid.

Kreusler obtained this material from the oat, but what Ritthausen and he named *oat gliadin* was a product of its further alteration by the chemical treatment to which it was subjected with a view to purification.

(3) When oats are first treated with water or 10 per cent solution of common salt, before extraction with dilute alcohol, the alcohol-soluble proteid undergoes alteration, and a body of different composition and properties results. In the table, III is the mean of closely agreeing analyses of this substance; it is much more soluble in dilute alcohol than I, and is not coagulated or transformed into an insoluble modification. When wet with absolute alcohol, the moisture attracted from the air soon renders it gummy and tenaciously adhesive, unlike I.

Its composition, as regards carbon, hydrogen, and nitrogen, is very near to that found by Dumas and Cahours, and also by von Bibra, for *gliadin* or *plant-gelatin* (extracted by hot alcohol from wheat gluten and remaining dissolved in the alcohol when cold).

(4) The chief proteid extracted by cold 10 per cent salt solution behaves toward reagents like the *myosin-globulin* from animal muscle, as first stated by Weyl. Contrary to Weyl's observations, however, the coagulation temperature (80° to 100° C.) is much higher than that of animal myosin (55° to 60° C.). This proteid appears to be the result of a transformation similar to that by which myosin is formed from myosinogen. Its composition is given under IV, and is very near to that of muscle myosin. The greatest proportion of this proteid extracted by salt solution from the oat was 1.3 per cent.

(5) The proteid extracted, after complete exhaustion of the oats with alcohol of 0.9 specific gravity, by 10 per cent salt solution (analysis under V), and that dissolved out by dilute potash (analysis under V*a*), have so nearly the same composition as the globulin extracted by salt solution directly that they may be regarded as originally identical, IV representing the soluble form V, and V*a* the insoluble or "albuminate" modification.

(6) When ground oats are directly extracted by weak potash solution without previous treatment with water or dilute alcohol, nearly the whole of the proteids is dissolved. The substance so extracted, after completely removing the body soluble in weak alcohol, is perhaps the same as that first designated *avenine* by Johnston and Norton, who extracted oats with dilute ammonia water. Its composition, as indicated by analysis of a single preparation, is stated under VI.

(7) When ground oats are exposed to the action of water, a large share of the proteids becomes insoluble in dilute potash solution, the amount so rendered insoluble increasing with the duration of the contact with water. One hour's treatment with

water rendered one half, and 24 hours' treatment rendered two thirds insoluble in 0.2 per cent solution of potash. The composition of the part soluble in potash, after action of water (and removal of the alcohol-soluble proteid), as found in analyses, the average of which is stated under VII, is the same as that of the globulin soluble in salt solution, IV. This proteid, obtained by extraction with potash, *after* the action of water, is probably the substance which Kreusler converted into his *oat legumin* by the "purifying" process to which he subjected it. It is also the "protein body" which Norton extracted by weak ammonia and analyzed.

(8) When ground oats are extracted with 10 per cent sodium chloride solution heated to 65° C., a proteid separates on cooling, in the form of spheroids. This substance differs in composition and properties from that obtained by cold salt extraction as well as from all proteids hitherto described. It is soluble in pure water, is precipitated from such solutions by a little sodium chloride, is again dissolved by a certain additional quantity, and is precipitated completely by saturation with this salt. In the presence of a little sodium chloride and acetic acid it is soluble in alcohol of 0.9 specific gravity. From solutions in distilled water, as well as from those in sodium chloride brine, it has been obtained crystallized in regular octahedrons. Analysis (of spheroids) under VIII.

(9) The aqueous extract of ground oats was found, in agreement with Norton and Kreusler, to contain very little proteid substance. The proteids thus dissolved appear to be, first, an *acid-albumin ;* second, a *globulin* or *globulins* similar in reactions to that extracted by 10 per cent salt solution, and third, a *proteose.* No true albumin was found in the water extract.

(10) In the salt extract a very small amount of a body was found, having the reactions of *albumin,* but not analyzed.

Table of composition of proteids from the oat kernel.

	I.	II.*	III.*	IV.	V.	Va.	VI.	VII.*	VIII.
Carbon	53.06	53.10	53.70	52.34	52.48	52.45	53.49	52.49	52.22
Hydrogen	6.94	6.91	7.00	7.21	6.94	6.92	7.01	7.10	6.98
Nitrogen	16.38	16.49	15.71	16.88	16.85	16.63	16.39	17.11	17.85
Sulphur	2.26	23.50	1.76	0.88	0.57	0.81	0.99	0.80	0.77
Oxygen	21.38		21.83	22.69	23.16	23.19	22.12	22.50	22.18
		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Average of several analyses.

The numbers over the analyses in the above table correspond with those of the paragraphs in the foregoing summary.

GRASS GARDENING, J. B. OLCOTT (pp. 162–174).—An account of the grass gardens of the station at South Manchester and New Haven, with suggestions with reference to the management of such gardens and their value for experimental purposes.

FEEDING STUFFS (pp. 175–182).—Analyses of cotton-seed meal, linseed meal, oil-cake meal, malt sprouts, brewers' grains, middlings, corn and oat feed, "Buffalo Sugar Feed," and salt herrings with reference to both food and fertilizing ingredients, and of field-cured and ensiled maize kernels with reference to food constituents.

The comparison of field-cured and ensiled corn was made on material sent to the station for that purpose. The analyses of the dry matter are "practically identical" and "go to show that there had been no material change in the composition of the kernels in the silo."

On the market price of the ingredients of feeding stuffs.—The author compares the market prices of concentrated feeding stuffs, as cotton-seed and linseed meal, with those of the mill products and corn. He states that "in our ordinary mill feeds, carbohydrates cost as much as albuminoids," and gives in support of this the following statement of the average cost of food ingredients in these materials for the years 1888 and 1890:

[Cents per pound.]

	1888.	1890.
Albuminoids (N. × 6.25)	1.6	1.4
Fat	4.2	2.9
Carbohydrates (including fiber)	0.96	1.4

"Cotton-seed and linseed meal, gluten meal, malt sprouts, and brewers' grains seem at present to be the most economical of our concentrated feeds."

THE COMPARATIVE EFFECTS OF PLANTING IN HILLS AND DRILLS ON THE QUANTITY AND QUALITY OF THE MAIZE CROP (pp. 183–194).—The piece of land used for this experiment was checked off into 24 twentieth-acre plats, so arranged that there were four rows of plats (north and south) with six plats in each row. Of these four rows of plats, the first row received 10.7 cords of cow manure per acre; the second row 13.3 cords of hog manure; the third row 1,700 pounds of a mixture consisting of 100 pounds of nitrate of soda, 80 pounds of sulphate of ammonia, 80 pounds of dried blood, 125 pounds of cotton seed meal, 90 pounds of dissolved boneblack, and 40 pounds of muriate of potash; and the fourth row received no fertilizers. Corn was planted on the first, third, and fifth plats in each row of plats, in drills 4 feet apart and with the stalks 10 inches apart in the drills, and on the remaining plats in rows likewise 4 feet apart, the hills being in different series of plats from 40 inches apart with four stalks in a hill, to 20 inches apart with two stalks in a hill.

"This arrangement of the field and fertilizers makes possible a comparison of the relative effects of planting in hills and drills on plats quite different as far as manuring goes, but otherwise believed to be quite uniform in quality. * * * In 1888 and 1889 this land had received very considerably more of both potash and phosphoric acid than had been removed in the crops of those years, but on the other hand the crops had removed some 60 pounds more of nitrogen from the soil per acre than had been replaced." An excess of seed was planted and the plants thinned out to the desired distances. The plants were all cultivated at the same time and in the same manner.

When harvested, "each crop was weighed and sampled from an area of one fortieth of an acre taken from the center of each plat." Analyses were made of the kernels and stover from each plat, which are given in

tables, and from these analyses the yield of dry matter and of each food ingredient is calculated for each plat and the averages for the plats receiving like applications of fertilizers.

In this experiment the maize planted in drills gave about 6 per cent larger yield of dry matter than the maize planted in hills, and also a larger yield of each food ingredient. * * * The composition of the crop, and therefore its feeding value per pound, were practically the same whether planted in hills or in drills.

The composition of the crops grown on the different fertilizers is practically the same; but where no fertilizer was applied the per cent of albuminoids in the crop is about 1.7 lower, with a corresponding increase in the per cent of fiber and nitrogen-free extract. * * *

It has been shown by our experiment of the 2 preceding years that the per cent of albuminoids in the crop may be strikingly increased or decreased by changing the distance of planting [see Annual Report of the station for 1889, p. 223, or Experiment Station Record, vol. II, p. 478].

The author gives tables showing the composition of the largest crop of dry matter raised in 1888 and 1889, and the largest yields in drills in 1890; the pounds of nitrogen, phosphoric acid, and potash applied to and taken from the soil in 1888, 1889, and 1890, and the gain or loss to the soil of these three ingredients by 3 years' cropping.

ON THE DETERMINATION OF PHOSPHORIC ACID IN PRESENCE OF IRON AND ALUMINA, S. W. JOHNSON, M. A., AND T. B. OSBORNE, PH. D. (pp. 195–197).—This is a comparison of the original and the "official" molybdic methods of determining phosphoric acid in the presence of iron and alumina on eight different materials. The authors point out the difference between the original molybdic method as elaborated by Sonnenschein and the method as recommended by the American Association of Official Agricultural Chemists, the precipitation being effected in the latter from a hot solution with digestion for 1 hour at 65° C., and in the former by adding "a large excess of molybdic solution [to the cold solution of the substance] and keeping for 4 to 6 hours at a temperature near to but not exceeding 50° C." With the "official" method, "when iron and aluminum are in the solution, these metals are to some extent carried down with the yellow precipitate, and when this is dissolved in ammonia they are also dissolved and pass into the alkaline filtrate and thence into the magnesium phosphate."

The results of determinations by both methods are tabulated. These results show differences of 0.5 per cent or over between the two methods in several instances, this difference amounting with one material (Keystone Concentrated Phosphate) to over 2 per cent of phosphoric acid. With a single exception the results were highest with the official method.

Georgia Station, Bulletin No. 12, April, 1891 (pp. 10).

FIELD EXPERIMENTS WITH FORAGE PLANTS AND ANALYSES OF THE PRODUCTS (pp. 47-54).—Tabulated data of yields and analyses of amber cane, white and yellow millo maize, Kaffir corn, Rural Branching

and Link Hybrid sorghum, pearl millet, teosinte, Blount Prolific corn, Brazilian Flour corn, and pop corn grown at the station in 1890.

Kansas Station, Bulletin No. 18, December, 1890 (pp. 18).

EXPERIMENTS WITH FORAGE PLANTS, C. C. GEORGESON, M. S., H. M. COTTRELL, M. S., AND W. SHELTON (pp. 175-191).—In view of the wide variation in the amount of rainfall in Kansas in different seasons, it is very desirable to find forage plants which will withstand drouth and furnish fodder for cattle when the corn crop fails. In 1890, for example, owing to drouth during July and August and the early frost in September, the corn crop on the farm of the Kansas Agricultural College did not furnish more than one third of the food required to carry the college herd through the winter. A table shows that the average rainfall in the months of May, June, and July, in the region of the station, has averaged 12.97 inches during the past 32 years. In 1889 the rainfall for 6 months amounted to 17.85 inches, while in 1890 it was only 6.54 inches.

Non-saccharine varieties of sorghum.—The experience at the station indicates that the non-saccharine varieties of sorghum should be planted in drills and cultivated in the same manner as corn, and that planting in rows 3 feet apart with the stalks from 4 to 8 inches apart in the rows, gives the most satisfactory results. "A greater yield per acre can be secured by planting the rows 2 feet to 30 inches apart, but the narrow space renders the work of cultivation much more difficult. As soon as the seed becomes hard the crop should be cut and shocked. * * * The heads should be cut off and threshed and the grain ground as fine as possible for the best results, and the fodder should be fed in racks."

The following is a summary of experiments in 1889 and 1890 with six non-saccharine varieties of sorghum:

Varieties.	1890.		1889.	
	Dry forage per acre, tons.	Cleaned seed per acre, bushels (60 lbs.).	Dry forage per acre, tons.	Cleaned seed per acre, bushels (60 lbs.).
Brown dhoura	7.04	*0.0	13.5	40.0
Egyptian Rice corn	3.47	16.5	....	....
Kaffir corn (white)	3.31	6.0	7.0	60.0
Red Kaffir corn	4.20	19.1	9.0	71.0
White millo maize	5.29	2.2	15.0	57.0
White African sorghum	5.48	18.3	....	....

* Killed by frost before seed matured.

Brief descriptive notes of each of the above-mentioned varieties were given, as well as a list of 45 imported varieties, chiefly from India and China, which were tested in 1890. Tabulated data and descriptive notes are given for eight of these foreign varieties which matured seed before frost.

(3) Teosinte yields heavy crops of excellent forage, much relished by stock. The average of a 3 years' test is a yield of 23.9 tons per acre.

Varieties of millet.--The following is a summary of a test with five varieties of millet in 1890:

Varieties.	Yield of hay per acre.	Days from seeding to heading.	Days from seeding to cutting.
	Tons.		
Broom corn	2.35	42	51
Common	2.10	50	65
German	2.68	50	85
Golden Wonder	1.95	....	85
Hungarian	2.55	44	51

Miscellaneous forage plants.—Brief notes are given on experiments with teosinte (*Euchlæna luxurians*), pearl millet, spring vetches, yellow lupine, thousand-headed kale, several varieties of soja beans (*Glycine hispida*), and other Japanese forage plants. The Kansas stock melons are described as a "non-saccharine variety of the watermelon, or possibly a cross between the citron and the watermelon, as the fruit partook of the solid character and lack of sweetness of the former, while it had the shape and size of the latter."

The flesh of these melons is firm and solid throughout, with comparatively few seeds. Cattle and hogs eat them greedily, but they have but little food value. An examination kindly made by the chemical department of this station showed them to contain 95 per cent of water and only 5 per cent of dry matter. They were fed experimentally to a portion of the herd, which will be reported on later. It may here be remarked that while they did not furnish much nourishment, they gave the animals a better appetite for dry food, and thus indirectly influenced the productive capacity of the stock. They furnish in a cheap form the succulent food which is so intensely craved by cattle in the winter months.

Varieties of silage corn.—Tabulated data are given for 14 varieties of corn tested in 1890.

Sorghum and corn for silage.—Tabulated data are given for 14 fifteenth-acre plats on which corn and sorghum were planted separately and also together in alternate rows and in the same rows. The average yields per acre were as follows: Corn and sorghum in alternate rows, 12.29; corn and sorghum in the same rows, 14.74; corn alone, 10.06; sorghum alone, 16.42 tons.

The sorghum when grown alone outyielded any combination of the two: but it is worthy of note that while the average of the plats with corn and sorghum mixed in the same rows reached 14.74 tons per acre, the average of the plats on which corn and sorghum are grown singly reaches only 13.24 tons per acre, the result thus supporting the theory of the effect of a mixture.

Summary.

(1) The non-saccharine sorghums are among our best drouth-resisting plants, and among them are several sorts that will yield good crops of seed in dry seasons, and the seed will compare favorably with corn for food.

(2) Of several varieties of millet tested, German millet gave the best yield of hay, followed in order by Hungarian, common, broom corn and Golden Wonder millet.

(4) Pearl millet has been a failure for three successive seasons, owing mainly to the apparent impossibility of getting a stand.

(5) Spring vetches failed to produce a paying crop in 1890.

(6) Yellow lupine was a failure in 1890.

(7) When roots or silage are not grown, Kansas stock melons can be grown and fed to advantage along with hay or other dry fodder. The yield is heavy, and the cost of culture and handling but slight.

(8) Thousand-headed kale will give a fair yield of forage, but heavier crops of more palatable feed can be grown at the same cost.

(9) Certain early varieties of the Japanese soja bean promise to be of much value for this country as heavy producers of a highly nitrogenous food.

(10) *Coix lachryma* and *Panicum frumentaceum*, two Japanese forage plants, were failures here in 1890.

(11) In a test during the past dry season of fourteen varieties of silage corn, only the following four kinds yielded more than 12 tons of silage per acre, viz, Mosby Prolific 14.39, Sheep's Tooth 12.92, Southern Horse Tooth 12.37, and Shoe Peg 12.15 tons per acre.

(12) A verdict of "not proven" must be given in the trial of growing a mixture of corn and sorghum *vs.* corn and sorghum grown singly, though there is some evidence in support of the theory that a mixture increases the yield.

Kansas Station, Bulletin No. 19, December, 1890 (pp. 10).

NOTES ON VEGETABLES, E. A. POPENOE, M. A., AND S. C. MASON, B. S. (pp. 193–202).—*The germination of weeviled peas.*—In view of differences of opinion among authorities as to the amount of injury to the seed of peas from the attacks of the pea weevil (*Bruchus pisi*), the following experiments were made at the station:

A germination test of weeviled beans in the greenhouse gave out of 1,800 beans, representing eighteen sorts, the following results: Fifty per cent started; of these, three fifths might have grown into plants, as the injury was restricted to the seed leaves; but the remaining two fifths were variously mutilated by the loss of a part or the whole of the germ or plumule, so that under no circumstances could they have made plants. * * * In a check lot of perfect beans of the same varieties and in the same numbers, planted side by side, 95 per cent germinated.

Of 500 peas of ten sorts tested in a similar manner, but one fourth germinated, and the partial destruction of the cotyledons rendered the further growth of these doubtful. A check lot of the same number of sound peas gave a germination of 97 per cent. An examination of 275 injured peas showed but 69 in which the germ was not wholly or partially destroyed.

In a field test of the growth of sound as compared with weeviled peas, the results were more decisive from a practical standpoint. In this test 23 varieties were represented, each by 100 sound and 100 weeviled peas, taken as they came, without further selection. The seeds were planted in the garden in parallel rows, the sound and weeviled peas of each sort side by side, the rows 18 inches apart. The planting was done on the 5th of June, and the dryness of the season hindered the perfect germination and growth to a noticeable degree. Of the sound peas 68 per cent came up, and 64 per cent made strong plants. In 10 varieties of the weeviled peas, no seeds germinated; the remaining 43 varieties were represented in all by 58 plants or 4.4 per cent, in germination, of which but 49, or 3.8 per cent, grew to average size and strength.

The inference is plain that weeviled seed should not be planted, because it is worthless compared with sound seed, and because by planting infested seed without

more care than usually taken to destroy the contained weevils, one thus simply propagates the insect for the sake of a minimum of return in plants. The proper course is to throw infested seed into the fire as soon as the insects are detected. As an easy mode of separating the sound from the unsound seed, it is suggested by Professor Riley, in his Third Missouri Report, that if thrown into water the infested seed will float, while the sound seed, being heavier, will sink.

Second-crop potato seed.—Tabulated data are given for an experiment in which potatoes were grown from the seed of first and second crops. The results indicated that by the use of second-crop seed, there is no gain in earliness, but the yield and size of tubers are greater. In a second crop of potatoes grown in 1890 at the station, the nine varieties planted yielded from 67 to 173 bushels per acre. "The product was of unusually fine quality and the yield a very good one, when it is considered that potatoes of ordinary planting were almost a failure in this section of the country."

Varieties of beans.—Out of 194 varieties planted in 1890 only 19 survived the drouth sufficiently to give even a moderate yield. Of these, Henderson Bush Lima, Dwarf Carolina, and a local variety known as Belcher gave especially good results. Descriptive notes are given on 10 varieties of Japanese beans grown at the station.

Cabbages.—The following varieties proved the most productive in the dry season of 1890: *Early.*—Burpee All Head, Early Newark Flat Dutch, Early Schweinfurth; *medium.*—Henderson Succession, Reynolds, Cassell; *late.*—Henderson Selected Late Flat Dutch, Burpee Surehead, Warren Improved.

Maine Station, Annual Report, 1890, Part II* (pp. 48).

TEST OF DAIRY COWS (pp. 17–42).—This is a continuation of the test of Ayrshire, Holstein, and Jersey cows, the first year's report of which was given in the Annual Report of the station for 1889, p. 106 (see Experiment Station Record, vol. II, p. 647). Each breed was represented by two registered cows, although the test with one of the Holsteins lasted but a single year. The food given in 1890 was the same as in 1889, except that no silage was fed and that one Holstein received a certain amount of middlings (170 pounds during the year) in addition to the regular ration. The daily ration consisted of 6 to 8 pounds of a mixture of two parts by weight of corn meal, and one each of cotton-seed meal and wheat bran, as much hay as the animals could eat clean, and pasturage during the summer months. A record was kept of the amount of each kind of food consumed by each of the cows during 1889 and 1890. In the present report the results for the 2 years are considered together.

Tabulated data are given for each cow as to the food eaten during the 2 years, cost of the same, yield and relations of milk and milk

* For abstract of part I of this report, see Experiment Station Record, vol. II, p. 345.

products, composition of the whole milk, skim milk, buttermilk, and cream, cost of food per pound of milk, food materials retained in the waste products of the dairy, and the loss of fat in the skim milk and buttermilk. The age, live weight, cost of food per year "reckoned at what are assumed to be average market values," average production of milk and butter, etc., are given for each animal as follows:

Record of individual cows.

Breed.	Age at beginning of the experiment.	Weight at beginning of the experiment.	Averages of the two years.										
			No. days milked per year.	Yield of milk per year.	Yield of milk solids per year.	Yield of butter fat per year.	Yield of butter per year.	Milk per pound of butter.	Cream per pound of butter.		Cost of food consumed per year.	Cost of food per pound of milk produced.	Cost of food per pound of butter.
Holstein:	*Yrs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*In.*		*Cents.*	*Cents.*
No. 1	6½	1,275	336	9,176	1135	319	317	28.96	5.01	2.52	$71.24	0.78	22.63
No. 2*	....	1,175	293	7,562	893	251	224	33.79	4.34	2.17	70.42	0.931	31.44
Ayrshire:													
No. 1	7	1,050	287	6,120	781	214	199	30.67	5.20	2.61	61.77	1.009	30.95
No. 2	4	1,020	291	7,105	906	253	197	36.02	4.87	2.43	63.21	0.89	32.06
Jersey:													
No. 1	7	870	348	6,540	987	314	374	17.46	4.18	2.06	59.74	0.916	15.96
No. 2	3½	920	336	4,381	667	250	255	17.30	3.95	1.98	58.76	1.345	23.08

* Test lasted only one year.

It is to be noticed that the expense of feeding a Holstein animal averaging 1,200 pounds in weight is only $11 per year more than the cost of feeding a Jersey animal averaging in weight only about 900 pounds; or in other words, the expense of feeding the heavier animals has been only about 18 per cent more than that of maintaining the lighter animals, whereas the Holsteins exceed the Jerseys in weight about 33 per cent. This is equivalent to saying that the quantity of food has not been in proportion to the weight of the animals, and * * * it is a well-recognized fact that the food of an animal does not increase in proportion to the increase in weight, or in other words, a small cow requires a larger maintenance ration in proportion to her weight than a large cow.

[The figures show further] that the Holsteins have produced milk solids considerably in excess of the other two breeds, and that the Ayrshires and Jerseys have differed very little in this respect. * * * When, however, we come to the consideration of the yield of fat we find that the Jerseys excel and that the Ayrshires stand lowest in the scale. * * * The food value of a quart of Jersey milk, such as that produced by the station animals, is worth 25 per cent more for purposes of nutrition than is the Holstein milk. While it may not be possible to grade the retail price of milk according to its quality, it would be entirely just for the milkman who is selling the product of a Jersey herd to receive a larger price than that which is paid for Holstein or Ayrshire milk. * * * The above table makes it very clear that cream is not of uniform value, and that the individuality of animals has a very marked influence upon the cream that is produced. Taking the average of a 2 years' record we see that the amount of cream required for a pound of butter has varied from 5.2 pounds in the case of the Ayrshire [No. 1] to 3.95 pounds in the case of the Jersey [No. 2]. The custom so far in Maine has been to pay the same price for equal volumes of cream, without regard to its source. This may be rank injustice, as the facts show.

In calculating the cost of the milk and butter produced per pound the first cost of the food alone is considered, no allowance being made

for the fertilizing ingredients of the food or the value of the buttermilk and skim milk.

The tabulated data show that "the Holstein milk cost the least and the Jersey milk the most when quantity alone is considered." The butter fat in the milk of the Ayrshires and Holsteins cost on an average "from 20 to 30 per cent more than in the case of the Jerseys."

Some interesting facts concerning the composition of the buttermilk, skim milk, and cream are presented in the following table, which is taken from the report:

Average composition of skim milk, cream, and buttermilk of the different breeds for two years.

	Skim milk.		Cream.		Buttermilk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Holstein	9.50	0.53	25.[illegible]0	18.30	9.70	0.45
Ayrshire	10.40	0.85	25.00	17.00	10.00	0.44
Jersey	10.50	0.37	27.90	19.80	10.30	0.19

First of all, it does not appear to be true that the cows producing the most and the richest cream are those that furnish the poorest skim milk. The proportion of cream from the Jersey milk has been much larger than from either of the other two breeds, and at the same time the Jersey skim milk proves to be the richest of all. * * * It is true with regard to both skim milk and buttermilk that [in solids] they follow the order of richness of the whole milk from which they come, or in other words, the poorer the whole milk, the poorer are the waste products of the dairy.

As will be seen, the average loss of fat in the skim milk and buttermilk was least with the Jerseys. "The Jerseys have uniformly produced the richest cream," as was shown both by analysis and by the churn. "As the time of parturition has approached, the amount of fat has been less in proportion to the other solids in the cream than while the cows were 'fresh.'"

The following statement shows the loss of milk solids and fat in the buttermilk and skim milk per year:

Average loss of solids and fat in buttermilk and skim milk for 2 years.

	Holstein.		Ayrshire.		Jersey.	
	No. 1.	No. 2.*	No. 1.	No. 2.	No. 1.	No. 2.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Yield of total milk solids	1,135	893	781	906	987	667
Yield of total cream solids	375	251.5	242.4	231.1	419	273.3
Yield of total skim milk solids	721.2	610.8	508.5	641.4	521.8	353.6
Yield of total buttermilk solids	107.8	60.8	73.5	60.9	105.7	62
Average per cent of total fat lost in buttermilk and skim milk	10.3	16.4	13.7	26.3	3.5	7.1

* Tested only one year.

The milk of all the cows was treated exactly the same, being "set in the same cabinet, with water at the same temperature, and for the same length of time."

The total amount of solid matter contained in a year's milk of the various animals ranged from 667 pounds up to 1,135 pounds, or an average of 895 pounds per year. There was retained in the skim milk and buttermilk from 416 up to 829 pounds of dry matter, or an average of 638 pounds of dry matter. This is 71 per cent of the total yearly production, or stated in another way, in making butter there is sent away from the farm only 29 per cent of the dry matter which the cows produce. It is worthy of note that seven eighths of this is contained in the skim milk.

Estimating the solids in the buttermilk and skim milk at 2 cents per pound, the average value of these per cow is calculated at $12.76 yearly.

MECHANICAL LOSS OF BUTTER FAT (pp. 43–45).—In previous experiments at the station it has been noticed that "the total amount of solids in the whole milk is not accounted for by the amount of solids in the skim milk and sour cream. The loss seems to have fallen especially upon the butter fat. It was found that not far from 10 per cent of the fat in the whole milk failed to appear in the skim milk and sour cream."

This matter was carefully tested in two separate trials by calculating for each four cows the actual amount of solids and fat in the whole milk and those in the skim milk and sour cream, during 5 days; and further by observations on over 200 pounds of milk of known composition. The data obtained in the latter test were as follows:

	Solids.	Fat.
	Pounds.	*Pounds.*
Contained in the whole milk	26.83	8.09
Contained in the sour milk and sweet cream	26.68	8.02
Contained in the sour milk and sour cream	26.34	7.77
Fat not accounted for in sour milk and sour cream		*0.32

*Or 4 per cent.

"In no instance was the amount of fat in the skim milk and the sour cream equal to that of the whole milk, the discrepancy or apparent loss, amounting in the several cows to from 4 to 7 per cent of the total fat in the milk. In the special trial, where a large quantity of milk is used, the fat of the sweet cream plus that of the skim milk accounts for practically that of the whole milk." The sour cream, however, "contained by analysis a quarter of a pound less of fat than the sweet cream."

EFFECT OF DELAY IN SETTING MILK (pp. 46–48).—Tests made to determine whether a loss of fat is entailed by allowing milk to stand from one half to an hour after milking before straining and setting, indicated that this treatment "does not seem to materially affect the completeness with which the cream will rise."

THE PREPARATION OF A RATION FOR MILCH COWS (pp. 49–51).—This is a comparison of the value of chopped and unchopped hay for milch cows. The trial was made in connection with the experiment with different breeds, described above. For 51 days the hay was chopped fine, moistened, and thoroughly mixed with the grain, no

other change being made in the ration. At the end of this time the animals were changed to the ration previously given, the hay being fed unchopped and the grain dry. Data as to the rations fed, composition of the milk, and the yield of milk and butter during each period are given for five cows. Regarding the value of the chopping and mixing, "there is no evidence that they had any effect."

MINERAL INGREDIENTS OF MILK, L. H. MERRILL, B. S. (pp. 52–57).—Analyses of the ash of whole milk and skim milk from Holstein, Ayrshire, and Jersey cows, and a calculation of the ash ingredients in 1,000 pounds of milk and skim milk, and in the whole milk and skim milk of a cow for 1 year for each of the three breeds.

The author finds the amount of potash and phosphoric acid contained in the milk and skim milk of one cow for 1 year to be as follows:

Yearly averages for one cow.

	Potash.		Phosphoric acid.		Total.
	Pounds.	Value.	Pounds.	Value.	Value.*
Whole milk	11.16	$0.50	13.42	$1.07	$1.57
Skim milk	9.53	.43	11.50	.92	1.35
Cream, by difference	1.63	....	1.92	....	.22

* Potash at 4½ cents and phosphoric acid at 8 cents per pound.

THE FAT GLOBULES OF MILK, L. H. MERRILL, B. S. (p. 58).—Tabulated data on the relative size and number of fat globules in the milk and skim milk of Holstein, Ayrshire, and Jersey cows.

As might have been expected, the larger globules have gone into the cream, leaving only the smaller ones in the skim milk. In no case do these average one half the size of those in the whole milk, and in the case of Jerseys they are less than one sixth as large. It is noticeable also that the globules in the milk of the two Jerseys are double the size of those of the other breeds, a fact which must in large part account for the ready creaming of this milk.

REPORT ON TUBERCULOSIS, F. L. RUSSELL, V. S. (pp. 59–64).—Notes on observations on two cases of tuberculosis in cows belonging to the college herd.

Massachusetts Hatch Station, Bulletin No. 13, April, 1891 (pp. 12).

DIRECTIONS FOR THE USE OF FUNGICIDES AND INSECTICIDES, S. T. MAYNARD, B. S. (pp. 3–10, figs. 3).—Brief directions for the preparation and use of sulphate of copper (blue vitriol), sulphate of iron (copperas), Bordeaux mixture, ammoniacal carbonate of copper, and Paris green, alone or in combination, for fungous diseases and insect pests of the pear, plum, peach, cherry, grape, strawberry, and potato. Spraying apparatus is illustrated.

Girdling grapevines, J. Fisher (pp. 11, 12).—An account of an experiment in 1890, in continuation of those reported in Bulletin No. 7 of the station (see Experiment Station Record, vol. II, p. 23), and the Annual Report for 1888 (see Experiment Station Bulletin No. 2, part I, p. 93). Analyses of samples of the grapes by C. A. Goessmann, Ph. D., are also reported. As in the previous experiments, the grapes on girdled vines ripened earlier (11 days, in 1890), " were sweet, with about the right proportion of acid," and were considerably increased in size. On some portions of the girdled vines, however, the fruit was inferior or worthless, and the question whether continuous girdling is injurious to the vine is yet to be solved.

The article also contains brief notes on an experiment in which muriate and sulphate of potash were compared as fertilizers for grapevines.

Massachusetts Hatch Station, Meteorological Bulletin No. 29, May, 1891 (pp. 4).

A daily and monthly summary of observations for May at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

Minnesota Station, Biennial Report, 1889 and 1890 (pp. 39).

This contains the reports of the director, agriculturist, entomologist, botanist, veterinarian, horticulturist, and chemist, and superintendent of the Owatonna substation, which include outlines of the work in the several departments of the station. The veterinarian, O. Schwartzkopff, D. V. M., reports that feeding tests with sheep indicated that the lead plant (*Amorpha canescens*) is not an injurious weed for these animals. He also gives a brief account of inoculation experiments with the virus of actinomycosis. In the case of three dogs and two cats the inoculation was unsuccessful, but a tumor, shown by microscopical diagnosis to be due to actinomycosis, was produced on a calf inoculated through the skin of the left lower jaw.

The station suffered a great loss by the burning of its office and laboratory building October 5, 1890, when the laboratory equipment, a large part of the library, all the reports, bulletins, and records, and many of the memoranda of station work were destroyed. During 1890 the mailing list of the station was increased from 4,000 to 20,000 names.

Missouri Station, Bulletin No. 14, April, 1891 (pp. 36).

Field experiments with corn and root crops, H. J. Waters.—A report on experiments which, with a few exceptions, were carried on during 1889 and 1890. They were mainly planned by J. W. Sanborn, B. S., director of the station until June 1, 1889, but were completed by the author. The work has been in the following lines: (1) Test of varieties; (2) manures; (3) preparation of soil for planting; (4) distance and thickness of planting; (5) cultivation of corn, (*a*) depth of cultiva-

tion, (*b*) effect upon soil moisture, (*c*) frequency of cultivation, (*d*) hilling and level culture, (*e*) tilled one way *vs.* cross-tilled; (6) drainage for roots and corn. Details are given in notes and tables.

Test of varieties.—Tabulated data are given for 41 varieties tested in 1889.

Edmond Dent and Cuban Queen—both yellow—led in yield among the early-maturing varieties, while Blount Prolific and Champion White Pearl of the white varieties, and Logan, Imperial, and Murdock Improved of the yellow are the most promising of the medium-maturing. Of the late-maturing, St. Charles White and Piasa King led in the yield among the white varieties, while Golden Beauty was, apparently, the best of the yellow.

The varieties were classified as early (maturing within 110 days), medium (120 days), and late (130 days). The following is a summary of the results by classes:

Summary showing yield, etc., of early, medium, and late-maturing varieties.

	Height of stalk.	Height of ear.	Yield of good ears.	Yield of nubbins.	Yield per acre	Yield of fodder per acre.	Fodder per bushel of corn.
	Feet.	*Feet.*	*Pounds.*	*Pounds.*	*Bush.*	*Pounds.*	*Pounds.*
Average of 13 early-maturing varieties	8.8	4.2	276	54	47	2,592	54.6
Average of 16 medium-maturing varieties	10.1	5.0	325	52	53.9	3,350	61.6
Average of 12 late-maturing varieties	10.3	5.5	293	59	51.4	3,696	72.1
Average of all varieties tested	9.7	4.9	300	54	50.9	3,209	63.0

"From this table it appears that the medium-maturing varieties average the largest yield of corn, the late-maturing next, and early varieties the smallest."

Similar results obtained at the Illinois Station (see Bulletin No. 4 of the station) are cited.

The relation between the height of the stalk and the yield is indicated in the following summary:

Table showing relation of height of stalk to yield of variety.

	Height of stalk.	Height of ear.	Yield of corn per acre.	Yield of fodder per acre.	Fodder per bushel of corn.
	Feet	*Feet.*	*Bushels.*	*Pounds.*	*Pounds*
Average of 5 varieties showing smallest yield	8.5	3.9	40.1	2,012	50.2
Average of 5 varieties showing largest yield	10.7	5.5	61.5	3,832	62.3
Average of 5 varieties having shortest stalks	8.3	3.9	41.4	2,074	50.1
Average of 5 varieties having tallest stalks	11.0	6.0	55.9	3,988	71.3

The averages of the five varieties giving the smallest yield and of the five varieties having the shortest stalks are practically identical throughout. On the other hand, there is no relation between the average of the five varieties having the tallest stalks and the five varieties giving the largest yield.

The table points to the conclusion that the limit of profitable production has been reached in our very early varieties with a small growth of stalk, except when grown for a special purpose.

Experiments with manures.—The object of these experiments was to get light on the relative value of the different kinds of farm manures and the different methods of their preparation and application. The

report covers the work for 1889 and 1890. In both seasons the corn planted was a common medium yellow dent variety. No manure was applied in 1890. On eight manured as compared with four unmanured plats, barnyard manure (about ten loads per acre) gave an increase of about 46 per cent in 1889 and 33 per cent in 1890 in the yield of corn and fodder. Horse manure gave better results than cattle manure.

A comparison of the solid and liquid manure from cattle when both were saved together, and an equal weight of solid manure alone, showed the largest yield for the 2 years from the plat having the liquid manure saved with the solid. Plowing under gave better results than any other method of applying tested. No benefit was derived from the use of salt, lime, or land plaster, while wood ashes gave a material increase of crop. In the trial of commercial fertilizers the increase was not sufficient to warrant the expense. In these trials corn responded more readily to an application of potash than either phosphoric acid or nitrogen.

Preparation of soil for planting.—These and the remaining experiments reported in this bulletin were conducted on an upland clay loam with a clay subsoil. As a rule, tenth-acre plats were used. "The variety of corn grown in 1889 was St. Charles White, a large, late-maturing white dent, and in 1890 Cuban Queen, a small, early-maturing yellow variety."

The trial of fall and spring plowing for carrots and corn resulted in a draw. In the test of thorough, little, and no plowing for corn for the 2 years, there was no difference in the yield. The plat having no preparation yielded more corn in 1889 than either of those that had been prepared, and less in 1890. A comparison of deep and shallow plowing for corn in 1890 showed a gain of 4.8 bushels per acre or 11.9 per cent in favor of shallow plowing. Depth, 4 inches for the shallow and 10 inches for the deep plowing.

Subsoiling showed no gain in 1889 for ruta-bagas, nor in 1890 for corn. In both seasons the trial was made on tile-drained land, where subsoiling is supposed to show to the best advantage.

In 1889 a period of excessive rainfall, extending from May 15 to June 1, brought out some interesting facts in the growth of the corn planted on differently prepared plats.

During the time the soil was completely saturated with water the plants on the thoroughly prepared land made little or no growth, became pale, and apparently suffered materially. The plants on the plat having no preparation continued to grow vigorously and maintain a rich, healthy color. This was less marked on the plat having partial preparation, the plants appearing to occupy an intermediate position, as it were. There is no material difference in the surface drainage of the plats. The wet weather was followed by a drouth and excessive temperature, during which time the order of growth was completely reversed—the plants on the thoroughly prepared land making a good growth and showing the effects of the drouth much less than on either of the other plats.

Distance and thickness of planting.

An average of the two seasons' work shows no difference in the yield from planting 3 feet 9 inches apart each way with 2, 3, or 4 grains in a hill. When planted either thicker or thinner there was a decreased yield, which in the case of thicker planting was accompanied by a material increase in the per cent of nubbins.

Cultivation of corn.

A trial of deep and shallow tillage gave an increase of 14.3 bushels per acre, or 21.7 per cent of the whole yield in favor of shallow tillage in 1889, and an increase for

the same method of tillage in 1890 of 12.6 bushels per acre, or 30.6 per cent as an average of duplicate plats. Average of both seasons for all plats gave an increase of 13.5 bushels per acre, or 25.2 per cent. A plat in the set having no tillage, the weeds being removed with a sharp hoe without stirring the soil, yielded in both seasons for the same plat, more than the deep-tilled plats, but less than the shallow-tilled. Weekly determinations of soil moisture for 11 weeks, ending August 6, in 1890, showed that the shallow-tilled plats had an average of 11.6 per cent more moisture than the deep-tilled plats, and 10 per cent more than the plat receiving no tillage.

In a test of different depths of cultivation with the hoe, running from 1 to 5 inches deep, there was less difference in the yield than in any test of depth of cultivation where field implements were used. It is probable that the better conservation of moisture by deep hoeing counteracts and balances to some extent the effect of root mutilation, as the New York State Station has shown that the moisture increased regularly with the depth of stirring. In their test the soil was stirred with a hoe or spade, and no crop was grown on the land tested. Then a perfect mulch is formed, but, as explained in the body of this report, no such covering is made by the ordinary field cultivator when run deep.

A light mulch of fine earth in one case, of sand in another, and of chaff in a third, spread to a depth of one half inch, gave as large a yield for 1889 as two adjoining plats having thorough tillage. The mulched plats were never tilled.

In a test of deep and shallow tillage where the root mutilation was equal, there was a gain of 5 bushels per acre, or 10.4 per cent in favor of shallow tillage, due, presumably, to the increased amount of moisture conserved. An effort to determine the stage of development of the plant at which the ill effects of deep tillage are least felt, showed a gain of 5.3 bushels per acre, or 12.4 per cent from tilling shallow, when the plants are small, and deep afterwards, as compared with deep tillage early and shallow afterwards. The trial was not made in duplicate, and covers but one season. The results need confirmation. The result of the experiment with frequency of tillage for two years, shows no relation between the amount of cultivation and the amount of corn harvested, so long as the weeds are kept down. This is in accord with experiments at the New York, Ohio, and Illinois Stations. A test of hill *vs.* level cultivation, where all other things were equal, showed an increase of 2.6 bushels per acre or 3.7 per cent in favor of hilling. The results are not decisive enough to be conclusive, but point to a probable advantage from hilling. A comparison of tilling one way continuously and cross-plowing once for both seasons resulted in a gain of 2.9 bushels or 5.3 per cent in favor of cross-cultivation.

Tile drainage for roots and corn.

A trial of the value of tile drainage on rolling clay upland shows a gain of 1.18 tons of mangel-wurzels per acre or 13.7 per cent in 1889 in favor of drainage; while, for 1890 with corn, the results are reversed, giving the undrained plats an advantage of 3.7 bushels per acre or 7 per cent. So far, the results are inconclusive. In 1890, the moisture in the first 7 inches of the soil, in both drained and undrained plats, was determined weekly for 11 weeks, ending August 6, showing no difference in favor of either system.

Nebraska Station, Fourth Annual Report, 1890 (pp. 371).

This includes a brief résumé of the work of each department of the station; a subject list of Bulletins Nos. 1–15, and Press Bulletins Nos. 1–5; the Treasurer's report for the fiscal year ending June 30, 1890;

the text of the act of Congress of March 2, 1887, and of the act of the State legislature, approved March 31, 1887, assenting to the act of Congress; and reprints of Bulletins Nos. 12–15 of the station. The subjects treated in these bulletins are: Bulletin No. 13, Experiments in the Culture of the Sugar Beet in Nebraska, H. H. Nicholson, M. A., and Rachel Lloyd, Ph. D. (see Experiment Station Record, vol. II, p. 111); Bulletin No. 14, Insects Injurious to Young Trees on Tree Claims, L. Bruner (see Experiment Station Record, vol. II, p. 115); Bulletin No. 15, Meteorological Report for 1889, DeW. B. Brace, Ph. D., and Soil Temperatures and Farm Notes, J. G. Smith, B. S. (see Experiment Station Record, vol. II, p. 240); Bulletin No. 12, Field Experiments for 1889, J. G. Smith, B. S. (see Experiment Station Record, vol. I, p. 254).

Nebraska Station, Bulletin No. 17, June 6, 1891 (pp. 72).

FIELD EXPERIMENTS AND OBSERVATIONS FOR 1890, J. G. SMITH, B. S. (pp. 1–32).—These were in continuation of those for 1888 and 1889, reported in Bulletins Nos. 6 and 12 of the station (see Experiment Station Record, vol. I, pp. 121 and 254). Drouth materially interfered with field work at the station, and the results for 1890 are comparatively meager. The subjects considered in the report are grasses and clovers, oats, silos and silage, and rainfall and evaporation.

Grasses and clovers (pp. 1–3).—Redtop (*Agrostis vulgaris*), orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), red clover (*Trifolium pratense*), alsike clover (*T. hybridum*), and white clover (*T. repens*) endured the drouth well and "seem to be the only species to be depended on in all seasons."

Alfalfa, which gives such abundant crops on bottom lands and under irrigation, though a strong grower does not seem to do well on upland meadows. It continued green and fresh during the entire season, but the yield does not compare with that of red clover.

The native wheat grass or blue joint (*Agropyrum glaucum*), resembling alfalfa in its strong and vigorous growth, makes too coarse hay and forage to compete with the finer-leaved cultivated species. It is not a success in this portion of the State, or at least not on upland soils. Its value farther west remains undisputed.

The only grasses now alive in the garden besides those mentioned above, are meadow brome grass (*Bromus pratensis*), tall meadow oat grass (*Arrhenatherum avenaceum*), sheep's fescue (*Festuca ovina*), red fescue (*F. rubra*), Kentucky blue grass (*Poa pratensis*) and sainfoin (*Onobrychis sativa*).

Oats (pp. 3–7).—Brief notes are given on the growth and yield of ten varieties of oats. In the dry season of 1890, press drilling, which puts the seed down deeper, gave a better stand, larger yield, and less loss by shattering than ordinary drilling or broadcasting.

Silos and silage (pp. 7–22).—Compiled statements are made concerning the advantages and disadvantages of silage, and replies to a circular of inquiry are given from five farmers in Nebraska who have successfully used the silo and found it to be an economical means for the storage of fodder.

Rainfall and evaporation for 1889 (pp. 23–32).—Tabulated data are given for six rain gauges and the same number of evaporimeters placed in different parts of the station farm. The observations were made from April 8 to November 1, inclusive.

METEOROLOGICAL REPORT FOR 1890, DEW. B. BRACE, PH. D., AND H. N. ALLEN, B. S. (pp. 33–72).—This is a continuation of the observations for 1888 and 1889, reported in Bulletins Nos. 6 and 15 of the station (see Experiment Station Record, vol. I, p. 123, and vol. II, p. 240), with the addition of data from six evaporimeters suspended at elevations of 4, 22, 40, 60, 80, and 100 feet, for the months of June to October inclusive; from six rain gauges for the months of April to October, inclusive; and from soil thermometers at depths of from 1 to 36 inches for the months of March to December, inclusive. The yearly summary is as follows: *Pressure* (inches).—Maximum 30.98; minimum, 29.36; mean, 30.08; annual range, 1.62; maximum daily range, 0.85. *Air temperature* (degrees F.).—Maximum, 103; minimum, −16; mean, 50.67; annual range, 119; maximum daily range, 47. *Humidity.*—Mean relative humidity, 67.95. *Precipitation.*—Total (inches), 14.81; number of days on which 0.01 inch or more of rain fell, 55. *Weather.*—Number of clear days, 136; number of fair days, 144; number of cloudy days, 85. *Wind.*—Prevailing direction, N and S; maximum velocity (miles per hour), 58; total movement (miles), 116,095. *Soil temperature* (degrees F.).—Maximum and minimum from March to December, 1 inch, 105 to 19; 3 inches, 101.5 to 24; 6 inches, 94 to 29.5; 9 inches, 89.5 to 32.2; 12 inches, 84 to 34; 24 inches, 70.5 to 39; 36 inches, 67.5 to 41.7.

Nevada Station, Third Annual Report, 1890 (pp. 38).

REPORT OF DIRECTOR, S. A. JONES, PH. D. (p. 4).—A brief statement regarding the work of the station.

FINANCIAL REPORT (pp. 5, 6).—This is for the fiscal year ending June 30, 1890.

REPORT OF AGRICULTURIST AND HORTICULTURIST, W. S. DEVOL, B. AGR. (pp. 6–30).

Forage plants (pp. 6–16).—Brief descriptive notes on the following species of plants sown on fortieth-acre plats in 1889, with a view to testing their adaptability to the dry climate of Colorado: Texas blue grass (*Poa arachnifera*), blue grass (*P. pratensis*), fowl meadow grass (*P. serotina*), wood meadow grass (*P. nemoralis*), redtop (*Agrostis vulgaris*), creeping bent grass (*A. stolonifera*), orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), Italian rye grass (*Lolium italicum*), perennial rye grass (*L. perenne*), meadow fescue (*Festuca pratensis*), tall fescue (*F. elatior*), red fescue (*F. rubra*), tall meadow oat grass (*Arrhenatherum avenaceum*), meadow foxtail (*Alopecurus pratensis*), Bermuda grass (*Cynodon dactylon*), velvet grass (*Holcus lanatus*), Johnson grass (*Sorghum halepense*), sweet vernal grass (*Anthoxanthum odoratum*), Hungarian grass (*Setaria italica*), golden millet (*S. italica*), pearl millet

(*Pennisetum spicatum*), red clover (*Trifolium pratense*), white clover (*T. repens*), alsike clover (*T. hybridum*), Japan clover (*Lespedeza striata*), spike clover or sweet clover (*Melilotus alba*), alfalfa (*Medicago sativa*), sainfoin (*Onobrychis sativa*), serradella (*Ornithopus sativus*).

Vegetables (pp. 16–30).—Brief notes on tests of 7 varieties of muskmelons, 6 of watermelons, 8 of potatoes in 1889 and 92 in 1890, 6 of sweet corn, 15 of beans, 24 of radishes, and 14 of cucumbers.

Fruits (p. 30).—A tabular statement of the number and varieties of trees planted in 1890.

REPORT OF ENTOMOLOGIST AND BOTANIST, F. H. HILLMAN, B. S. (pp. 31–34).—A brief outline of the work of the year.

REPORT OF CHEMIST, J. W. PHILLIPS, D. SC. (pp. 35–38).—This includes tabulated analyses of fifteen samples of soils from different localities in Nevada.

New Jersey Stations, Bulletin No. 79, February 28, 1891 (pp. 20).

EXPERIMENTS WITH NITRATE OF SODA ON TOMATOES, E. B. VOORHEES, M. A.—Experiments were made in 1890 on two different farms within the State for the purpose of testing the effects of different amounts of nitrate of soda on tomatoes, when used alone or in connection with phosphoric acid and potash, and when applied all at one time or in two separate portions.

Each experiment was made on 12 twentieth-acre plats, treated as follows: Nitrate of soda, 8 and 16 pounds, was used alone and in connection with a mixture of 8 pounds of muriate of potash and 16 pounds of boneblack superphosphate, being applied in four cases all at one time, previous to setting the plants, and in four cases in two separate equal applications, one previous to setting and the other a month later. One ton of barnyard manure was used on one plat; one plat received a mixture of 8 pounds of muriate of potash and 16 pounds of boneblack superphosphate; and two plats remained unfertilized.

In the case of one of the experiments, the season was such as to prevent the drawing of conclusions. The statements following relate to the other experiment, which was made on the farm used for a similar experiment in 1889.

"The seeds from which the plants were secured were planted under glass, in February, 1890. Only strong and stocky plants were selected for the experiment. They were set 4 feet apart each way, with two rows on each plat, giving 136 plants per plat. The plats were laid out and the fertilizers applied May 9. The plants were set May 9, 10, and 13, beginning at the ends of the rows, and setting from side to side across the whole number of plats."

The yield of tomatoes at different pickings, the value of the crop, and the relation of yield and value of the early pickings to the total yield and value of the crop are tabulated for each plat.

Does nitrate of soda increase the yield at the expense of maturity?—The total yield and the total value of the crop were larger in every case where nitrate of soda was used. The yield and value of "early" tomatoes (picked between July 7 and August 5) were also larger where the nitrate was used, except in the two cases where 16 pounds of nitrate of soda was applied all at one time. In these two cases the average yield of early tomatoes was the same as that of the unfertilized plats. However, while the yield of early tomatoes was (with two exceptions) larger with nitrate of soda, the percentage of early tomatoes in the whole crop was lower with the nitrate than with barnyard manure or no fertilizer. The nitrate, therefore, "did not increase the maturity in the same ratio as the yield."

In the opinion of the author the results of this experiment "emphasize the general conclusions reached last year: (1) That nitrate of soda did not increase the yield at the expense of money value of early tomatoes when applied in small quantities [8 pounds per plat], or in large quantities [16 pounds per plat] in two applications. This was equally true for nitrate of soda both when used alone and when used in connection with phosphoric acid and potash. (2) That nitrate of soda did increase the yield at the expense of money value of early tomatoes, when large quantities were added in one application, in the presence of a sufficient excess of phosphoric acid and potash."

Influence of season on the effect of nitrate of soda.—It is stated that in 1890, while the yield of early tomatoes on the unfertilized plats was 89.4 per cent and their value 77.5 per cent higher than that of the preceding year, the yield of early pickings where nitrate of soda was used was only 53.8 per cent and their value 25.5 per cent greater than in 1889. Therefore, "while the relative effect of nitrate of soda is the same each year for the different quantities and methods of application, the actual effect on both yield and value of early tomatoes was much less in 1890 than in 1889."

For comparison, the yield and value of the total crop from each plat in 1889 and 1890 are tabulated.

[The table] shows that the average increase in total yield, due to nitrate manuring, was 297 baskets or 40 per cent in 1889, and 396 baskets or 42.1 per cent in 1890. In other words, the application of an average of 240 pounds of nitrate of soda per acre produced in 1889, 297 baskets of tomatoes, and in 1890, 396 baskets. The increased effect of an equal amount of nitrogen as nitrate in 1890 over 1889 was therefore equivalent to 99 baskets of tomatoes or 33.3 per cent. * * * The increased yield of 396 baskets or 42.1 per cent, in 1890 increased the value of the total crop but $106.08 or 29 per cent, while the increase in yield of 297 baskets or 40 per cent, in 1889 increased the value of the total crop by $119.96 or 46.2 per cent. It is clearly shown, therefore, that under the conditions which existed this year the nitrate of soda was more completely used by the crop than in 1889, but resulted in produce of lower value. These results are chiefly of interest in showing the influence of season, and do not change the general conclusion in regard to the value of nitrate of soda as a fertilizer for tomatoes.

Financial considerations.—"Properly used, the nitrate of soda is a profitable fertilizer for tomatoes." The net value (total value less cost of the fertilizers) of the crop on the unmanured plats in 1890 is given at $366.04 per acre. The highest net value per acre, $492.90, an increase of $126.86, was secured with the use of 160 pounds of nitrate of soda alone, applied in two separate portions.

The smallest net gains were secured from the use of barnyard manure; the largest from nitrate of soda alone. In three cases out of four, net gains were increased by two applications of nitrate of soda. In three cases out of four the 320 pounds of nitrate of soda per acre produce greater net gains than 160 pounds.

These conclusions are substantially identical with those secured from the study of yields, and show that financial profits from the use of nitrate of soda are also governed by the quantity applied, the method of application, and a full supply of mineral elements in the soil.

New Jersey Stations, Bulletin No. 80, March 14, 1891 (pp. 31).

EXPERIMENTS WITH FERTILIZERS ON POTATOES, E. B. VOORHEES, M. A. (pp. 3–24).—In order to ascertain the general practice followed in potato culture, the station sent out circulars "to about one hundred of the leading growers in the State," inquiring as to the crop and fertilizers usually preceding potatoes, the method of planting potatoes, variety used, kinds and amounts of fertilizers used, method of cultivation, average yield, and the average cost of labor expended on the crop.

The replies show a marked uniformity of practice, except in the amount of the plant food furnished by the manures used. The general practice may be stated as follows: Precede with a crop of corn treated with 10 or 12 tons of barnyard manure broadcast; prepare the ground thoroughly; cut the potatoes with one or two eyes and plant 4 to 5 inches deep in rows furrowed 3 feet apart, placing the pieces 12 to 15 inches apart in the row; broadcast barnyard manure at the rate of 10 to 20 loads per acre, and add chemical manures in the row at the rate of 300 to 600 pounds per acre; harrow before potatoes come up, and continue once or twice a week until plants are 3 inches high; then cultivate 3 or 4 times, or as often as possible until the vines have their growth. The leading varieties reported were, in their order, Early Rose, Silver Lake, Mammoth Pearl, Beauty of Hebron, and White Star. The yield reported ranged from 100 to 450 bushels per acre, 20 per cent of the number reporting more than 200 bushels, and but 6 per cent less than 150 bushels per acre. The cost of the crop, not including the manure or fertilizer, averaged $30 per acre.

A report is given of the first year's experiment carried on in 1890 at the college farm and two private farms, to compare the effects on potatoes of barnyard manure, "chemical manures," and a mixture of the two; of potash in the forms of sulphate, muriate, and kainit; and of nitrate of soda when applied all at once and in two portions at different times.

The soil of the college farm is described as "a gravelly, clay loam, with tight, red clay subsoil, and not especially adapted to potatoes. It had been in alfalfa since 1887, for which it was well manured. The soil of one of the private farms consisted of a medium sandy loam, with dry,

open subsoil, in a good state of fertility, and was well adapted to potatoes; that of the third farm was a light, sandy loam of rather medium fertility.

Each experiment was made on 14 twentieth-acre plats. Three of the plats received no fertilizers; on the remaining 11 plats 16 pounds of boneblack were combined, in separate cases, with 8 pounds of muriate or sulphate of potash, or 32 pounds of kainit per plat, and combinations of boneblack (16 pounds) with each of these different potash fertilizers were used with 10 pounds of nitrate of soda per plat, the latter being in some cases applied all at the time of planting and in others part at time of planting and part a month later; 1 ton of barnyard manure was used on one plat, and 1,000 pounds of barnyard manure, with half quantities of the mineral fertilizers, on another plat.

Early Rose potatoes were planted at the college and Burbank on the other two farms. The seed potatoes were cut to two eyes, and planted from 12 to 15 inches apart in rows 2½ feet apart. The potatoes were dug at the convenience of the farmers, and 5-pound samples taken from each plat for analysis. The yield of large and small potatoes and the total and net value of the crop at 75 cents per bushel for large and 40 cents per bushel for small potatoes, are tabulated for each plat in each experiment, and the average yields of the unfertilized plats, and of those receiving barnyard manure, mineral fertilizers, and a mixture of the two, are given for each separate experiment.

Relative effect of the different methods of fertilizing.—The following table shows the average results of plats receiving similar treatment at each farm:

Average results per acre of different methods of fertilizing.

	Cost of fertilizer.	Yield.	Value.	Net value.	Gain(+)or loss (--).
Farm No. 1 (college):		*Bushels.*			
Unfertilized	....	161.6	$113.73	$113.73	....
Barnyard manure	$30.00	203.6	142.20	112.20	—$1.53
Mineral fertilizers	11.19	158.9	110.38	99.19	—14.54
Mixture of manure and fertilizers	21.77	205.9	146.52	124.75	+11.02
Farm No. 2:					
Unfertilized	....	140.0	101.28	101.28	....
Barnyard manure	30.00	149.0	108.62	78.62	—22.66
Mineral fertilizers	11.19	175.2	129.34	118.15	+16.87
Mixture of manure and fertilizers	21.77	202.6	147.75	125.98	+24.70
Farm No. 3:					
Unfertilized	....	73.0	47.19	47.19	....
Barnyard manure	30.00	143.3	103.98	73.98	+26.79
Mineral fertilizers	11.19	143.6	101.52	90.33	+43.14
Mixture of manure and fertilizers	21.77	191.6	137.89	116.12	+68.93

"A study of the table shows that the application of 200 pounds of nitrogen, 200 of phosphoric acid, and 100 of potash in 20 tons of barnyard manure per acre, was followed by the lowest yield in all cases, and was profitable only on [farm No. 3]; that an average application of 20 pounds of nitrogen, 50 of phosphoric acid, and 80 of potash in the form of complete chemical manures was profitable on two farms; and that a combination of one half of the barnyard manure and one half of the

chemical manure used in the other methods gave the largest yield and was profitable in all cases."

Effect of the different forms of potash salts.—The yields with complete fertilizers, containing potash in the form of sulphate, muriate, or kainit, as tabulated, show that in each case the muriate gave a slightly increased yield (from 10 to 19 bushels per acre) over the sulphate. "The kainit was the least effective and in a few cases proved an injury."

Effects of nitrate of soda.—Nitrate of soda, applied all at time of planting or part at time of planting and the rest later, seems to have been practically without effect. "The reason for its failure to aid in the production of the crop is not clear, since the general experience of both experimenters and practical farmers is that uniformly good results have followed its use upon potatoes."

Chemical composition of the crop.—Analyses with reference to both food and fertilizing ingredients are given for samples of potatoes from each plat in each of the three separate trials.

The results from all the experiments agree very closely with each other, though a very marked difference is noticed in the effect of the different forms of potash. It has already been shown that manures, grouped either according to the form of potash or as a whole, did unfavorably influence the percentage of dry matter in the potato. Of the three forms of potash used, the sulphate was the least unfavorable, since it reduced the dry matter in the average of all the experiments but 0.68 pound in 100 pounds of potatoes or 3.1 per cent; and the kainit was the most unfavorable, and on the same basis reduced the dry matter by 2.59 pounds or 11.8 per cent; the effect of the muriate corresponded to the average general effect. It is also shown that the starch was affected by the different kinds of potash in the same relative proportion as the dry matter.

The teachings of these experiments do, therefore, accord with the opinions now generally held, and based upon previous experiments, namely, that potash does influence the composition of potatoes, and that of the different commercial forms the sulphate is the most valuable.

The author states further, that in general, while the potatoes on the plats receiving sulphate of potash were not as large, they were of more uniform size and of smoother skin than those on the plats fertilized with either muriate of potash, kainit, or barnyard manure. When cooked, the potatoes from the sulphate plats were believed to be of superior quality.

"As in the composition of food compounds, the variations in the amounts of plant-food elements contained were not marked in the samples from different plats in each experiment." The amount of fertilizing ingredients removed by the crop on each farm and the amounts left in the soil from the various applications, are calculated.

The chief points brought out by the experiments of this year are summarized as follows:

(1) The best results were secured when chemical manures were used in connection with barnyard manure.

(2) Kainit was less effective than either muriate or sulphate of potash; and sulphate of potash did not produce larger yields than muriate.

(3) Nitrate of soda did not prove a valuable fertilizer for potatoes.

(4) Potash does influence the composition of potatoes; and of the different commercial forms, the sulphate is the most valuable.

Though something has been learned from these experiments, further study seems imperative, for there is no one question so important to the general farmer of this State as the study of soils and crops in regard to the economical use of manures.

FIELD EXPERIMENTS WITH FERTILIZERS ON WHEAT, E. B. VOORHEES, M. A. (pp. 25–31).—These experiments, made on the land of a farmer in the State, were "planned to study the effects of nitrogen as nitrate of soda when used either alone or in connection with either one or both of the elements of potash and phosphoric acid."

The 5 tenth-acre plats used for the trial were used for an experiment with oats in 1889, and were fertilized for that crop as follows: Plats 1 and 5, unfertilized; plat 2, 150 pounds muriate of potash; plat 3, 300 pounds of "boneblack superphosphate," and plat 4, the two materials combined.

In the experiment with wheat, plat 1 received nitrate of soda 160 pounds per acre; plats 2 and 3, the same amount of nitrate with respectively 160 pounds of muriate of potash and 320 pounds of boneblack superphosphate; plat 4, the three materials combined; and plat 5 remained unmanured. One fourth of the nitrate of soda was applied at the time of seeding (September 24) and the remainder in the spring (April 29, 1890).

The yields of good and poor wheat and of straw, the weight of wheat per bushel, the analyses of the wheat and straw, and the amounts of fertilizing ingredients removed from the soil are tabulated for each plat. The following summary is taken from the bulletin:

Comparison of yields per acre.

	Wheat.	Straw.
	Bushels.	*Pounds.*
Unmanured land	12.7	1,555
Gain from nitrate of soda alone	5.8	925
Gain from nitrate of soda with potash	5.0	905
Gain from nitrate of soda with phosphoric acid	9.5	1,515
Gain from nitrate of soda with phosphoric acid and potash	12.6	1,585
Increased gain due to phosphoric acid	3.7	590
Increased gain due to phosphoric acid and potash	6.8	660

It will be observed that while the nitrate alone increased the yield by 5.8 bushels, its best effect, 12.6 bushels of wheat and 1,585 pounds of straw, or an increase of 100 per cent, was secured only when there was a full supply of the mineral elements. The presence of these influenced the quality of the product, as shown by the weight of measured bushel and by the amount of poor wheat.

Allowing $1.10 per bushel for the wheat and $5 per ton for the straw, the profit per acre is calculated to be as follows:

With nitrate of soda alone	$4.98
With nitrate of soda and potash	0.45
With nitrate of soda and phosphoric acid	6.42
With nitrate of soda, phosphoric acid, and potash	6.41

The author gives, in closing, directions as to the use of nitrate of soda on wheat.

New Mexico Station, First Annual Report, 1890 (pp. 8).

This contains a brief statement regarding the organization and equipment of the station, an outline of the experiments planned, and a financial statement for the fiscal year ending June 30, 1890. During 1890 the station published two bulletins, abstracts of which may be found in Experiment Station Record, vol. II, pp. 418, 419.

New York State Station, Bulletin No. 29 (New Series), April, 1891 (pp. 20).

FEEDING EXPERIMENTS WITH LAYING HENS, P. COLLIER, PH. D. (pp. 447–464).—The experiments made at the station in 1889, as to relative effects of rations containing different proportions of nitrogenous materials for laying hens, were continued in 1890. The experiment here reported extended from November 15, 1889, to November 15, 1890, and was made with four pens of fowls. The following rations were fed to fowls of both the smaller (single-combed White Leghorns, and white-crested Black Polish) and the larger breeds (Plymouth Rocks, Light Brahmas, and Buff Cochins):

Pen 5, 6 hens, smaller breeds....Oats, corn on the cob, and a mixture of linseed meal, bran, and ground oats.
Pen 6, 8 hens, larger breeds .....Nutritive ratio, 1.423 to 4.39.
Pen 7, 6 hens, smaller breeds.....Oats, corn on the cob, and corn meal.
Pen 8, 8 hens, larger breeds.....Nutritive ratio, 1.56 to 5.63.

Thus, while in addition to oats and corn on the cob, pens 5 and 6 received a grain mixture containing from 22.4 to 24 per cent of crude protein, pens 7 and 8 received corn meal containing 11.5 per cent of protein. All the fowls were given corn silage, red clover, and at times meat scraps.

"The fowls of contrasted pens were similar in regard to breed, age, and immediate parentage, and until 5 months old were under the same conditions of feeding, etc., but for the year preceding this trial were under rations of the same character for each pen respectively as those fed during this last period. The year for which the results are here given included the whole of the second laying season, all the fowls being mature, averaging about 17 months old when this experiment began."

The results are tabulated in detail for each pen. The average results per hen for the whole year are given as follows:

Average number and weight of eggs produced per fowl during one year and food consumed per day.

		No. of eggs.	Weight of eggs.	Total water-free food per day.
			Ounces.	*Ounces.*
Pen 5, smaller fowls	more nitrogenous ration	43.7	91.48	2.43
Pen 6, larger fowls	more nitrogenous ration	48.9	108.24	3.30
Pen 7, smaller fowls	corn-meal ration	68.7	136.20	2.57
Pen 8, larger fowls	corn-meal ration	50.1	112.16	3.27

Thus in the case of both the larger and the smaller breeds the number and weight of eggs were larger with the corn-meal ration than with the more nitrogenous mixture, this difference being greater with the smaller fowls. The fowls "having the corn-meal ration continued to lay for the longer period." In the previous experiment, while the smaller fowls produced more eggs with the corn-meal ration than with the more nitrogenous mixture, the results with the larger fowls were slightly in favor of the more nitrogenous ration.

The fowls having the more nitrogenous ration were always in better health, and their plumage, except during a short molting period, was always full and glossy, while those having the more carbonaceous ration were oftener sick and their plumage was always ragged and dull. For some time during the first year the vices of feather-pulling and egg eating were common among the latter. * * *

There is no doubt that during the laying period the fowls of both larger and smaller breeds receiving the corn meal, were fatter, for at nearly all times during this feeding trial the handling and weights of the birds indicated it.

At the close of the experiment the hens were all confined in small pens and given all they would eat of the same rations they had been receiving. After 6 weeks 19 of the 28 hens were killed and dissected. Data with regard to the live weight of the fowls, the weight of different parts of the body, and the relation of live weight to dressed weight, of lean meat to dressed weight, etc., are tabulated. The general average of the fowls killed showed the fowls receiving the more nitrogenous food to have become fatter than those receiving the corn-meal rations; but the author believes "there is no doubt that most of the fat was accumulated during this period of close confinement and heavy feeding without much exercise." The bones of those hens which had received the corn meal ration continually for 2 years "were, on the average, for each lot, heavier."

The number of eggs laid by the same hens during the second season "was but little less than that of the first season." Their average size was as follows:

	First year.	Second year.
	Ounces.	*Ounces.*
Smaller breeds, nitrogenous ration	1.85	2.09
Smaller breeds, carbonaceous ration	1.93	1.99
Larger breeds, nitrogenous ration	2.12	2.21
Larger breeds, carbonaceous ration	2.12	2.24

The cost of feeding hens entirely from the feed box for 4 months between the first and second laying season, is calculated at about 19 cents per fowl for the smaller breeds and 24 cents for the larger. "Unless pullets can be produced at less cost there would appear to be but little advantage in replacing hens for the first year, as is so often recommended, except where great difference in the market value of 1 and 2-year-old fowls exists."

General conclusions.

The results of several feeding experiments indicate that for laying fowls of smaller breeds Indian corn or corn meal can be fed in quite large proportion with a consid-

erable margin in its favor over certain more nitrogenous foods; but that while smaller fowls, even when confined, suffer little serious disadvantage under the ration, larger breeds will not endure for long periods a very large proportion of corn meal in their food, and unless at liberty, will do better with a somewhat more nitrogenous ration.

New York State Station, Bulletin No. 30 (New Series), May, 1891 (pp. 16).

CABBAGES AND CAULIFLOWERS, IMPORTED VS. AMERICAN SEED, P. COLLIER, PH. D. (pp. 465–470).—A report of tests made at the station in view of the fact that it has been claimed that better results may be obtained with the cauliflower and cabbage seed grown in this country, especially in the region of Puget Sound, Washington, than with imported seed. Details are given in five tables. In 1889 a test between Eastern and Puget Sound cauliflower seed resulted in favor of the latter. In 1890, imported, Long Island, and Puget Sound seed of both cabbages and cauliflowers were used.

The results seem to show that neither the Long Island nor the Puget Sound seed is in any way inferior to the imported seed. * * * The largest and heaviest seed made a quicker germination and a more vigorous growth immediately after being transplanted. These are both valuable considerations, as it often happens that a severe drouth or the attacks of the flea beetle cause the loss of a large number of plants in the seed bed or before they recover from the shock of transplanting. * * *

Only about half (58.46 per cent) of the early-planted cauliflowers developed heads, while 96.12 per cent of the late-planted reached maturity. In the case of the cabbages, 75.61 per cent of those planted early made marketable heads, although half of the varieties were those usually termed winter cabbages and seldom planted for summer use. The late planting of cabbages gave 96.34 per cent of marketable heads.

From a financial standpoint, however, the early planting gave more remunerative results.

TOMATOES, COMPARISON OF METHODS OF GROWING, P. COLLIER, PH. D. (pp. 471–478).—Tabulated data of yields and descriptive notes on the varieties compared are given for an experiment, which is described as follows:

In these tests 7 plants each of 19 of the newer varieties of tomatoes were used. The plants were set in a young vineyard that had been top-dressed with bone meal at the rate of 200 pounds per acre, the soil being in a good state of tilth. In setting the plants, each row was run east and west. A wire trellis was then run north and south, to which the eastern plant of each variety was trained. The next plant in each row was trimmed at frequent intervals, thus allowing the sunlight to penetrate to the soil and also reach every fruit. The 3 following plants were allowed to grow at will. The sixth plant was trained to a stake, being tied up as required, and the extreme western plant was trained to a wire trellis. The trimmed plants in almost every case gave the first ripe fruits, but both the west trellis and staked plants ripened 10 fruits as early as did the trimmed plants. Both the west trellis and staked plants of every variety yielded a very small crop. This is accounted for by the fact that there was a heavy clay knoll running through the vineyard. * * * During the fruiting season there was a very heavy rainfall. * * * In every case but one

the yield of ripe fruit was smaller than the yield of green fruit, making the yield of ripe tomatoes fall below the average. In this immediate vicinity the green fruit sold for about as much as the midsummer and late ripe ones, causing but little loss to the grower. It will also be noticed that the plants allowed to grow at will gave a larger yield per plant than any others, but the fruit was much later in ripening, in fact the greater portion of green fruits were picked from these plants.

The fruits on plants tied to trellis or stake were on an average of larger size and more symmetrical. For a small garden, either system will be found preferable to allowing the vines to grow at will, but in commercial growing the advantages are not enough to pay. The Chemin, Early Ruby, and Cleveland No. 115 proved the best of the early varieties. Matchless, McCulloms, and Cleveland No. 57 gave the largest yield.

TOMATOES FROM GREEN AND RIPE SEED, P. COLLIER, PH. D. (pp. 478–480).—Brief notes on experiments carried on during 8 years (1883–90). The results up to 1890, as summed up in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 598), indicated that the green seed would produce earlier and more numerous but smaller fruits, together with weaker vines.

The season of 1890 gave much the same results, the plants from immature seed ripening fruits 10 days in advance of those from mature seed; the growth of vines in 1890 was more vigorous than in previous years and the fruits larger. This was probably due to the fact that the specimen fruit selected for seed in 1889 was of large size, and while very green had nearly obtained its maximum development. * * * It is yet a question of how much further towards a perfectly ripe fruit it will be best to go to procure seed that will give more vigor of plant and still retain the early-ripening qualities of immature seed.

Oregon Station, First and Second Annual Reports, 1889 and 1890 (pp. 13 and 18).

These include financial statements for the years ending June 30, 1889 and 1890, the regulations of the board of regents of the State Agricultural College for the government of the station, brief outlines of the work, and a synopsis of Bulletins Nos. 1–7 of the station.

South Dakota Station, Bulletin No. 24, May, 1891 (pp. 15).

EXPERIMENTS WITH CORN, L. FOSTER, M. S. A. (pp. 152–164).—A brief account of the results of experiments with varieties of corn and on the time and thickness of planting and methods of cultivation, carried on at the station during 3 years (1888–90). A previous report on this series of experiments was published in Bulletin No. 9 of the station (see Experiment Station Record, vol. I, p. 18). The original purpose of the experiments was to find out whether corn could be successfully grown in this section. Tabulated and descriptive notes are given on 14 flint and 7 dent varieties which have proven best adapted to the part of South Dakota in which the station is located. The experiments thus far made indicate that, (1) the best time for planting in this locality is between May 10 and 20, and (2) that the season of

growth before injurious frosts is about 100 days from May 15. Experiments in 1890 with different distances of planting in hills and drills and with deep and shallow cultivation, are briefly recorded.

Tennessee Station, Bulletin Vol. III, No. 6, December, 1890 (pp. 14).

This contains an index to vols. I, II, and III of the bulletins of the station.

Tennessee Station, Bulletin Vol. IV, No. 1, January, 1891 (pp. 54).

CRAB-GRASS HAY, C. W. DABNEY, JR., PH. D. (pp. 4–8, fig. 1).—Brief descriptive notes on crab grass (*Panicum sanguinale*), with tabulated results of analysis of this and other plants. In a brief introduction to the bulletin the director of the station makes the following statement regarding this plant:

> Throughout the Northern and Middle States crab grass, or finger grass as it is sometimes called, is regarded only in the light of a weed and a pest. In this State, while often playing the part of a weed (and a very persistent one too) in gardens and hoed crops, crab grass under certain conditions becomes of much value both for summer pasturage and for hay. It springs up in corn and grain fields after these crops are harvested, and frequently yields a large amount of hay, which though bulky, is, as determined by the chemist, more nutritious, weight for weight, than timothy.

The results of analyses made at the station and elsewhere are reported in the following table:

Composition of various kinds of hay and grass.

	Moisture.	In 100 parts of dry matter there are—							
		Protein or albuminoids.	Ether extract or fats.	Nitrogen-free extract or carbohydrates.	Crude fiber.	Crude ash.	Total nitrogen.	Albuminoid nitrogen.	Nutritive ratio.
Andropogon argyreus	8.40	4.25	2.00	58.83	31.06	3.92	0.68	0.66	1 to 15.0
Tall redtop	8.74	6.62	2.45	54.85	31.56	4.52	1.06	1.00	1 to 9.2
Timothy hay*		8.62	3.02	49.34	33.92	5.10	1.38	1.21	1 to 6.4
Orchard-grass hay*	13.64	9.62	3.85	38.04	41.97	6.52	1.56	1.29	1 to 4.9
Crab-grass hay, ours, 1889	5.98	9.25	2.93	45.84	27.16	8.82	1.48	(‡)	1 to 5.7
Crab grass hay, ours, 1890	5.87	10.12	3.68	53.06	26.82	7.32	1.62	1.33	1 to 6.0
Mature crab grass,† C. Richardson	14.30	9.78	2.82	42.70	32.09	12.61	1.57	1.06	1 to 5.0
Crab grass† cut June 23, C. Richardson	76.50	23.13	4.84	37.99	19.03	15.01	3.70	(‡)	1 to 2.1

* New York State Station Annual Report for 1888.
† U. S. Department of Agriculture, Division of Botany, Special Bulletin on Grasses and Forage Plants.
‡ Not determined.

SORGHUM AS A FORAGE PLANT, P. F. KEFAUVER (pp. 9–14).—Compiled notes on the advantages of sorghum as a forage plant, with brief accounts of experiments by the author in raising this crop and feeding it to animals. In the case of dairy cows it was found to be desirable to combine cotton seed or cotton-seed meal with the sorghum in order to keep up the yield of butter.

TEST OF FEEDING VALUE OF FIRST AND SECOND CROPS OF CLOVER, C. S. PLUMB, B. S. (pp. 15–20).—The following experiment to compare the feeding value of first and second crops of clover hay in fattening steers was made during the winter of 1889–90. Four grade Shorthorn steers about 2 years old were divided into two equal lots, and fed rations containing either first or second cuttings of clover, with wheat bran and corn meal, during 14 periods of 10 days each. The animals were fed alternately on the two rations, lot 1 receiving first-crop clover, while lot 2 received second-crop clover, and *vice versa*. Cut wheat straw was fed to some extent with the second-crop clover. The composition of the clover and straw is given as follows:

Composition of first and second-crop clover and wheat straw.

[Averages for two analyses made at different periods.]

	Clover.		Wheat straw.
	First crop.	Second crop.	
	Per cent.	*Per cent.*	*Per cent.*
Moisture	8.91	8.29	5.57
Crude ash	7.69	7.13	4.33
Crude cellulose	23.05	31.28	38.54
Crude fat	3.34	2.26	1.61
Crude protein	12.94	13.12	13.50
Nitrogen-free extract	44.07	37.92	46.45
	100.00	100.00	100.00

The first-crop clover "was well eaten," but the second-crop clover "was eaten reluctantly, and its use was accompanied with more or less salivation." The food consumed and the gain in live weight of the four animals while on each ration are calculated as follows:

Food consumed and live weight gained by four steers.

	Clover.	Straw.	Bran.	Corn meal.	Gain in live weight.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
First crop	3,401.50	....	1,010.00	2,020.00	638
Second crop	1,059.25	1,076.75	1,008.50	2,316.50	100

"According to these figures, it required of first crop of clover and grain 10 pounds of food to 1 pound of gain. It required of second crop of clover and grain 54.6 pounds of food to 1 pound of gain."

PASTURE GRASSES, F. L. SCRIBNER, B. S. (pp. 21–25, plates 3).—Descriptive notes on Texas blue grass (*Poa arachnifera*), velvet grass (***Holcus lanatus***), and Tennessee fescue or glaucous creeping fescue (***Festuca rubra***, var. *glaucescens*). Of the three plates with which the article is illustrated, two are from Beal's Grasses of North America, but the third is original. Tennessee fescue is the name given by the author

to a variety of *Festuca rubra*, first discovered by Dr. A. Gattinger "growing on the limestone cliffs along the Cumberland River near Nashville, in 1867." As far as known it has not been observed outside the limits of Tennessee.

It is a near relative of the red or creeping fescue of Europe, and like that, has a creeping or stoloniferous root. It is therefore an excellent turf-forming grass, with good staying qualities, and will doubtless withstand well the tramping of stock. In our latitude it remains green the year round, being little affected by drouth or the severe cold of winter, and its great mass of fine root leaves will yield rich grazing wherever it is allowed to become well established. Its flowering stems grow to the height of 2 feet or more; it blossoms in May, maturing its seed in July. It is to be recommended only for pastures, but there, especially upon worn-out soils and hill slopes, we are confident that it will prove of great value.

Tests of this grass will be made at the station.

BLACK KNOT OF THE PLUM AND CHERRY, F. L. SCRIBNER, B. S. (pp. 26–28, plate 1).—Descriptive notes on *Plowrightia morbosa*, with suggestions as to remedies. The illustrations are from *Orchard and Garden*, and after Farlow.

PRUNING FRUIT TREES, R. L. WATTS, B. AGR. (pp. 29–31).—General instructions regarding the pruning of fruit trees.

GLASSY-WINGED SOLDIER BUG, H. E. SUMMERS, B. S. (pp. 32, 33, figs. 2).—Descriptive notes on *Hyaliodes vitripennis*, Say, which preys upon the grapevine leaf hoppers.

DISEASES OF LIVE STOCK, W. B. NILES, D. V. M. (pp. 34–36).—In view of the fact that a disease resembling "staggers" was causing serious injury to horses, mules, and cattle in Tennessee, Dr. Niles of the University of South Carolina, was sent for to make an investigation of the trouble. In this article he states that he was convinced that "the disease affecting horses and mules is the same as the disease called 'staggers' in Virginia, North Carolina, South Carolina, and some other States. The disease affecting cattle appears to be a different trouble, and is very probably the same as the trouble which annually appears in some of the Northwestern States, and which is by some called the 'cornstalk' disease."

The probable causes of these diseases are discussed and suggestions are made regarding treatment.

EXPERIMENT STATION RECORD (pp. 37–54).—Abstracts of bulletins Vols. I, II, and III, taken for the most part from Experiment Station Bulletin, No. 2, part I, and Experiment Station Record, vols. I and II, of this Office.

Tennessee Station, Bulletin Vol. IV, No. 2, April, 1891 (pp. 21).

PEANUT CROP OF TENNESSEE, STATISTICS, CULTURE AND CHEMISTRY, L. P. BROWN (pp. 55–73).—"Tennessee's crop of peanuts for the year 1889 was not far from 550,000 bushels, worth, at a low estimate, 90 cents per bushel, a total value of $495,000. The total crop of the United States in 1889 was probably about 2,700,000 bushels. In 1890

the crop was much larger." It costs about 40 cents per bushel to grow peanuts in Tennessee, and the average price to the producer is from 95 cents to $1.05. The average crop is from 40 to 60 bushels per acre, and the money return is from $22 to $40 per acre. In Tennessee peanut growing is mainly confined to six or seven counties in the center of the State. The soil used is sandy or gravelly clay, with a clay subsoil, and is derived from siliceous limestones and sandstones.

Two kinds of peanuts are grown in Tennessee, viz, white and red. The white variety is produced in much the larger quantity, as they bring about 25 cents per bushel more than the red. The red nut is so called from the color of the skin of the kernel. The white nut has a skin nearly or quite white, but which darkens with age. The white nut has a more spreading habit of growth than the red, is said to be more prolific, and is later in coming to maturity. The red matures better because earlier, and yields fewer imperfect pods, called "puffs" or "pops."

Tabulated results of analyses by the author of different parts of the peanut plant, are given and compared with the analyses made elsewhere of this and other crops. The original analyses reported in this article are as follows:

Composition of peanuts grown in Tennessee.

	Moisture.	In 100 parts of dry matter there are—				
		Protein or albuminoids.	Ether extract or fats.	Nitrogen-free extract or carbohydrates.	Crude fiber.	Crude ash.
Kernel of peanuts:						
Crop, 1888	3.87	28.65	49.35	17.23	2.37	2.40
Crop, 1889	4.86	27.07	48.60	19.30	2.52	2.51
Peanut meal	10.64	49.63	6.33	31.67	6.06	6.31
Peanut hulls	8.81	6.42	1.34	17.14	73.07	2.03
	7.81	7.94	2.17	13.36	65.81	3.63
Peanut hay	7.83	11.75	1.84	46.95	22.11	17.04

Ash analyses of peanuts.

	In 100 parts of dry ash there are—						
	Phosphoric acid. P_2O_5.	Potash K_2O	Soda Na_2O	Lime CaO	Magnesia MgO	Sulphuric acid. SO_3	Silica.
Kernels of peanuts	38.90	39.85	2.85	4.11	1.83	10.40	0.20
Hulls of peanuts	5.63	31.78	7.85	27.01	12.60	8.89	4.13
Leaves of peanut vines	4.85	15.00	7.26	50.77	10.89	3.57	5.60
Stems of peanut vines	5.34	19.23	7.52	25.80	19.67	7.42	9.93

Summary.—(1) The best results in peanut growing are to be obtained only by careful attention to details, such as selection and preservation of seed, careful preparation of the ground, care in selecting seed, and good culture of the peas. Only in this way can the planter always be sure of getting just returns for his labor, no matter what the prices are.

(2) The peanut is one of the richest vegetable foods known. Peanut meal is fully equal to cotton-seed meal as a feeding stuff. It is, however, hardly known in this country for this use.

(3) Until some other use is found for them, the hulls, which accumulate in considerable quantities at the recleaners, are practically a waste product, as they have only a small fertilizing value and are not used as a fodder.

(4) The practice of feeding the hay is one long established, and for this purpose it seems to be about equal to clover hay, especially for cattle.

(5) Experience in Virginia and North Carolina seems to indicate that a moderate use of commercial and home-made fertilizers would pay growers of peanuts in Tennessee. From the analyses and from what we know of the needs of similar plants, it is suggested that experiments be made with home-mixed fertilizers giving 15 pounds of nitrogen, 10 pounds of available phosphoric acid, and 20 pounds of potash per acre.

West Virginia Station, Third Annual Report, 1890 (pp. 190).

REPORT OF DIRECTOR, J. A. MYERS, PH. D. (pp. 4–29, plates 4).—This includes the text of the acts of Congress and of the State legislature relating to the station, and a financial statement for the fiscal years ending June 30, 1889 and 1890; a description of the station building and its equipment, with ground plans and a view of the exterior; and brief statements regarding the work of the station.

THE CREAMERY INDUSTRY (pp. 29–88, plates 3, figs. 6).—In this article the author points out the more important factors essential to success in butter making, mentions the different devices for raising cream by setting, gives the history of the development of the centrifugal apparatus so largely used in one form or another in creameries, describes its manner of working, and illustrates and describes several of the different forms. The article also contains tabulated data and summaries of observations on the separation and churning of cream for each month from November, 1889, to June, 1890, inclusive; analyses of sweet-cream butter; a description of the method of butter analysis; the results of churn tests of milk; and full descriptions of the Short, Patrick, Cochran, Babcock, and Beimling (Vermont Station) methods of determining the amount of butter fat in milk, the apparatus used in all except the first being illustrated by cuts.

"The average of the churnings of acid cream and sweet cream for the period beginning November 1, 1889, and closing June 30, 1890, show that it required 3.95 pounds of acid cream to make one pound of butter, and 3.74 pounds of sweet cream to make one pound of butter."

In the churn test made for 9 days to study the reliability of this method of determining the amount of butter which may be separated from cream, "in five cases out of nine the overchurning of the cream gave an average of 6.36 ounces more of butter per hundred pounds of milk than did churning the cream to the granulated condition. In four cases out of nine tests the overchurning of the cream gave an average excess of 3.32 ounces per hundred pounds of milk in favor of churning to the granulated condition."

Suggestions are made as to the execution of the various quick methods of determining fat in milk, with a table, prepared by B. H. Hite, for

converting the degrees of the Beimling test to per cent of fat. The results of comparative determinations of the fat in samples of cream, whole milk, buttermilk, and skim milk by the Beimling, Babcock, Cochran, and Soxhlet methods, and the Adams gravimetric method are also stated. Comparing the Beimling and Babcock methods, the former "gives somewhat higher results in our hands than does the Babcock process and is more rapid." The results by the Beimling "compare very favorably with the results by the Adams method," and "taking it all in all, we hold this method of analysis of milk in very high esteem." The results by the Babcock method, "while very uniform among themselves, ran appreciably lower than analyses made by the Adams method." This was especially true in the case of skim milk or buttermilk.

In the limited number of comparisons of the Cochran and Soxhlet methods with the Adams, the results varied from those by the Adams method by 0.2 per cent or over in about half the cases, the difference being in several cases over 0.4 per cent of fat.

Report of Botanist and Microscopist, C. F. Millspaugh, M. D. (pp. 89–144, plates 4, figs. 17).—This includes brief statements regarding the flora of West Virginia; notes on a tour of observation in the State made by the author in the summer of 1890; brief descriptive notes on sixty species of trees and shrubs growing on the campus of West Virginia University; a list of the native trees and shrubs of the State; a brief account of an experiment begun in 1890 with several varieties of Austrian basket osiers; notes on the Canada thistle (*Cnicus arvensis*), which were also published in Bulletin No. 10 of the station (see Experiment Station Record, vol. II, p. 745); and a somewhat detailed account of the processes and apparatus of photography in its application to station work. The report is illustrated with a map of West Virginia, two plates showing the Canada thistle at different stages of its growth, and numerous cuts exhibiting different pieces of photographic apparatus.

The boundary line of West Virginia has become a synonym for irregularity, the truth of which a glance at the map accompanying this report will show. The topography of the State might be comprised also, suggesting as it does an immense field over which a gigantic plow, drawn by a powerful griffin, which, goaded into frenzy with the trident of its Plutonic follower, had left in its erratic leaps and flights a confused maze of deep and irregular furrows. This topographical condition is mainly due to the great number of rapid-flowing streams, which, rising in the higher mountain ranges of the eastern and southern borders, pass in varied courses through the State to augment the Ohio west and northwest and the Potomac in the northeast.

Among the low as well as the loftier mountain ranges, there is comparatively little table-land; and in the valleys a like absence of extensive bottoms, except along Tygart's Valley River in Randolph County, the Great Kanawha, and the Ohio. The absence of ponds and lakes is remarkable, not one to my knowledge existing within the boundaries of the State.

The predominating soil of the hills and valleys is clayey and sandy alluvium, stiff clay, and loam, with some calcareous matter admixed in certain sections. The rocks

are principally sandstone, limestone, and shale. The special features of the now very fertile and then quite sterile soils compounded of the above deposits and rocks, we need not enter into in this place; suffice it to say that our soils give us a varied flora, and one often widely different in localities only a few miles apart. * * *

With the exception of a few transient botanists who have worked over, for their own personal pleasure, the neighborhood of some vacation resort in the State, the only attempts at obtaining a knowledge of the vegetable resources of the State may be summarized as follows:

1867 and 1871. Dr. A. S. Todd, as chairman of a committee of the Medical Society of West Virginia, published a list of the medicinal plants of West Virginia. This list contains an enumeration of 9 trees, 7 shrubs, and 60 herbs.

1870. Mr. DissDebarr, State commissioner of immigration, in his Handbook of West Virginia, compiled a list of the timber trees of the State, in which he enumerated 52 species and added 12 species of shrubs.

1876. Professor Fontaine in compiling his portion of the centennial volume upon the Resources of West Virginia, listed more carefully the forest trees, shrubs, and medicinal plants of the State, drawing the last from the publication of Dr. Todd. This work contains an enumeration of 69 trees and 16 shrubs.

1878. Profs. H. N. Mertz and G. Guttenberg published a check list of the flora of West Virginia, being an account of work done along the upper Ohio bottoms, and in the mountains of the northeastern portion of the State, the latter while located at Harper's Ferry. This list enumerates 59 trees, 37 shrubs, and 494 herbs.

Miss Verona Mapel, preceptress of the high school at Glenville, Gilmer County, has quite thoroughly worked over her immediate vicinity in connection with her school duties. She reports 42 trees, 23 shrubs, and 290 herbs. Her list does not include the commoner weeds and herbs, nor the grasses or sedges.

Judge Frank A. Guthrie, of Point Pleasant, at the mouth of the Great Kanawha River, has carefully worked his vicinity, which includes the bottom lands of the Ohio and Kanawha Rivers and the adjacent ridges.

REPORT OF ENTOMOLOGIST, A. D. HOPKINS (pp. 145–180, plates 2).—This includes notes on a number of species of farm and garden insects and a preliminary report on investigations of forest and shade-tree insects.

Farm and garden insects (pp. 147–163).—Notes are given on the following insects, including accounts of life history, observations by the author, and statements regarding experiments with insecticides: Striped flea beetle (*Phyllotreta vittata*), sheep tick (*Melophagus ovinus*), plum curculio (*Conotrachelus nenuphar*), codling moth (*Carpocapsa pomonella*), imported currant worm (*Nematus ventricosus*), house fly (*Musca domestica*), Colorado potato beetle (*Doryphora 10-lineata*), currant worm (*Pristiphora grossulariæ*), white grub (*Lachnosterna fusca*), wireworms, cabbage worm (*Pieris rapæ*), cabbage pionea (*Pionea rimosalis*), apple tree tent caterpillar (*Clisiocampa americana*), stock borer, grain plant louse (*Siphonophora avenæ*), peach tree borer (*Ægeria exitiosa*), apple tree borer, horn fly, and raspberry gouty gall beetle (*Agrilus ruficollis*). The account of the raspberry beetle is accompanied by a plate containing nine original figures. Two parasites were discovered by the author on the larvæ of this insect, which were determined at this Department to be, respectively, a new species of *Bracon* and *Charitopus magnificus*.

Forest and shade-tree insects (pp. 164–180).—An account is given of observations by the author in August, 1890, on locust trees in the vicinity of the station, which were seriously injured by the ravages of insect pests.

The region thus affected, so far as I have since observed, extends through Doddridge, Harrison, and Preston Counties, from Grafton westward to near the Wetzel County line, from Fairmont through Monongalia County to the Pennsylvania line, and from Piedmont southward through Tucker, Randolph, Upshur, and Lewis Counties. The trees are unaffected through Ritchie and Wood Counties and along the Ohio River, as far as was observed, the leaves being fresh and green at the time they seemed to be dying in the infested districts mentioned. This dead and scorched appearance of the locust trees at a time of year when they are noted for their beautiful green foliage, was, as far as can at present be learned, first noticed in Harrison County about the year 1885, when a few scattering trees were observed to turn brown. The number of trees thus affected rapidly increased each year until every tree, bush, and sprout of this species looked as if it had been killed by fire. This trouble continued to spread until at present at least one fifth of the State is affected.

While over forty species of insects were found to be feeding on different parts of the affected trees, one species, the locust hispa, appeared to be the principal cause of the trouble.

Notes are given on the locust hispa (*Odontota dorsalis*), *O. nervosa*, locust borer (*Cyllene* [*Clytus*] *robiniæ*), locust tree carpenter moth (*Xyleutes robiniæ*), locust sprout and twig borer, yellow locust midge (*Cecidomyia robiniæ*), six undetermined species of leaf miners, locust-skipper butterfly (*Eudamus tityrus*), and seven undetermined species of locust leaf rollers and pasters. A plate containing nine figures illustrates the article.

An account is also given of observations by the author and of information derived from other sources, regarding the causes of the death of large tracts of black spruce (*Picea mariana*) timber in West Virginia. The following summary is taken from the report:

The spruce forests of West Virginia are estimated to exceed 500,000 acres.

Isolated portions in these forests are dead, possibly to the amount of 150,000 acres.

While conducting an investigation in one of these affected portions [Cheat Mountain region] the author observed that all of the characteristic dead trees there bore abundant evidence of the attack of insects belonging to the family Scolytidæ.

A number of small trees were found partly dead and dying, near where trees had been cut last summer.

Great numbers of bark and timber beetles were found in the bark and sap wood of these dying trees both in the green and dead portions.

Three species of parasites (*Trigonoderus*, *Helorus*, and *Spintherus*, n. sp.) of these beetles were plentiful, and were noticed flying around and on the bark of the infested trees. Some of them were observed with their ovipositors inserted into the bark, while others were entering and emerging from the burrows made by the beetles. Here evidence was obtained of the possibility of these beetles being destroyed or reduced by natural means to such an extent that they could no longer be destructive to trees.

These same beetles were found to be very plentiful in the logs, stumps, and tops of last summer's cuttings near these dying trees.

There was very little evidence of the attack of these beetles on the stumps and tops of the 1887 cuttings, indicating that at or near the time the timber ceased dying in this locality these insects were not plentiful.

The conclusion arrived at from personal observation and notes leads me to believe that the death of the trees is probably due to the comb ned effect of two causes:

(1) The ravages of the insects primarily succeeded some injury to probably a few trees in isolated localities.

(2) When the conditions were no longer favorable to their existence in the injured trees, and they had increased to great numbers, the possibility of their attacking the healthy trees from sheer necessity and continuing to spread until checked by some natural cause, seems to me evident. I reach this conclusion from the fact that I have found these same scolytids working in the green, sappy wood and bark.

Still further investigations will be made in the spruce forests of the State in this and other localities, and a final report will appear in a future bulletin. This bulletin will also contain a list of all insects taken in these forests, and such other additional facts as may be determined.

REPORT OF AGRICULTURIST, D. D. JOHNSON, M. A. (pp. 181–185).—Brief statements regarding the plan on which the station conducts coöperative experiments with farmers, and the farmers' institutes carried on under the auspices of the station.

Wisconsin Station, Bulletin No. 27, April, 1891 (pp. 13).

THE FEEDING VALUE OF WHEY, W. A. HENRY, B. AGR.—"One hundred pounds of average milk contain about 13 parts of solids. In the process of butter making most of the fat is removed by skimming, leaving nearly all of the other solids. In cheese making the casein is coagulated by rennet so that nearly all of it is recovered. Most of the fat goes with the casein also. The albumen, a valuable food product, is not coagulated by the rennet, but remains in the whey, as does most of the ash." The constituents of 100 pounds of average milk, and of the buttermilk and skim milk, or the whey from the same, are calculated as follows:

Ingredients of 100 pounds of whole milk and the by-products from the same.

	Casein.	Albumen.	Fat.	Sugar.	Ash.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
One hundred pounds of average full milk contain about	3.5	0.7	3.5	4.5	0.7
The skim milk and buttermilk together from the above 100 pounds would contain about	3.4	0.7	0.3	4.4	0.7
The whey from the above 100 pounds would contain about	0.1	0.7	0.4	4.3	0.6

Four feeding trials were made with pigs during the fall and winter of 1890–91 to ascertain the value of sweet whey for pigs, and the most advantageous manner of feeding it. "In each trial one lot of pigs received grain only. This consisted in one instance of corn meal and shorts, half and half; in the others, of two thirds shorts to one third corn meal. Three pounds of water were mixed with each pound of the grain ration to form a slop; in the other cases, whey in varying proportions was fed mixed with the meal to form a slop. In all cases the whey was fed sweet."

The first trial was with 12 pigs, from 5 to 5½ months old at the beginning of the trial, and lasted from November 17 to December 22. The grain mixture consisted of equal parts of corn meal and shorts. The four lots of 3 pigs each received the following rations: Lot I, grain mixture and water; lot II, 2 pounds of whey to 1 pound of grain mixture; lot III, 9 pounds of whey to 1 pound of grain mixture; and lot IV, 10 pounds of whey to 1 pound of shorts.

The second and third trials extended from February 23 to March 30. The same pigs were used in the second trial as had been used in the first, but the division into four lots was such as to form new groups. Sixteen pigs, about 6 months old, were used in the third trial, and were divided into four lots. The grain mixture in both trials consisted of one part by weight of corn meal to two of either shorts or middlings The several lots in both trials were fed as follows: Lots I, grain mixture and water; lots II, 3 pounds of whey to 1 pound of grain mixture; lots III, 6 pounds of whey to 1 pound of grain mixture; and lots IV, 10 pounds of whey to 1 pound of grain mixture.

In the fourth trial, 6 pigs, about 9 months old, were divided into two equal lots, and fed from March 2 to March 30, as follows: Lot I, grain mixture, consisting of equal weight parts of corn meal and shorts, and water; and lot II, 6 pounds of whey to 1 pound of the same grain mixture.

For at least one week previous to the beginning of each trial the pigs were fed the same rations that they were to receive during the trial. Tabulated data showing the food consumed and gain in live weight by each pig are given for each trial, together with a general summary of the four trials by lots. The general summary of the results of the four trials is as follows:

Summary of four trials.

	Food consumed.		Total gain in live weight.	Food for 100 pounds gain.		Grain saved by whey.	Whey substituted for 100 pounds of grain mixture.
	Grain mixture.	Whey.		Grain mixture.	Whey.		
First trial: Average weight of 12 animals, 127 pounds.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Lot I	486	....	105	463	....	....	....
II	504	1,058	154	327	687	136	505
III	300.5	2,124	117	257	1,815	206	881
IV	215.5	2,226	119	181	1,871	282	663
Second trial: Average weight of 12 animals, 240 pounds.							
Lot I	627.5	....	101	621	....	....	....
II	627.5	1,856	161	390	1,153	231	499
III	453	2,676	124	365	2,158	256	843
IV	347.5	3,459	132	263	2,620	358	732
Third trial: Average weight of 16 animals, 140 pounds.							
Lot I	632.5	....	130	486	....	....	....
II	632.5	1,871	170	372	1,100	114	964
III	454	2,710	157	289	1,726	197	876
IV	352.5	3,509	152	232	2,309	254	909
Fourth trial: Average weight of 6 animals, 323 pounds.							
Lot I	543	....	85	639	....	....	....
II	394.5	2,297	111	355	2,069	284	728

"The average of the ten lots shows that 760 pounds of whey effected a saving of 100 pounds of the corn meal and shorts mixture by partial substitution. * * * The tables seem to show that the whey has increased the availability of the ration by more than the solids added to it in the whey."

Reference is made to experiments by Fjord,* in which 1,200 pounds of whey left in the manufacture of cheese from centrifugal skim milk were equivalent to 100 pounds of barley or rye meal, when fed as a partial substitute for the latter.

The author gives the following conclusions from his experiments:

(1) We were not successful in maintaining pigs on whey alone.

(2) Pigs fed on corn meal and shorts with water required 552 pounds of the mixture for 100 pounds of gain.

(3) When whey was added to the corn meal and shorts mixture it produced a marked saving in the amount of grain required for good gains. This was true for mixtures varying from 2 pounds of whey to 1 of grain up to 10 pounds of whey to 1 of grain.

(4) It was found when using whey as a partial substitute for grain that 760 pounds of whey effected a saving of 100 pounds of the corn meal and shorts mixture.

(5) Using these figures, if corn meal and shorts are valued at $12 per ton, then whey is worth 8 cents per hundred pounds; at $15 per ton for the corn meal and shorts, whey would be worth 10 cents per hundredweight.

(6) Shorts, pea meal, and oil meal or like feeds should be mixed with whey for growing animals. Some corn may be fed at all times, the proportion increasing as the animal approaches maturity.

Wyoming Station, Bulletin No. 1, May, 1891 (pp. 24).

ORGANIZATION OF THE STATION, D. McLAREN, M. S. (pp. 3-6).—The station was established as a department of the University of Wyoming by an act of the State legislature, approved January 10, 1891. The present Director was elected March 27, 1891.

In order that the possibilities of agriculture in all parts and altitudes of Wyoming may be fairly tested, the trustees have established experiment farms in various portions of the State. The west central portion and the altitude of 5,500 feet above sea level is represented by the Lander experiment farm of 137 acres, under irrigation, in Fremont County, and donated by its citizens. The Laramie Plains and the altitude of 7,000 feet is represented by the Wyoming University experiment farm of 640 acres in Albany County, irrigated from the Pioneer Canal, and granted by the Wyoming Central Land and Improvement Company. The North Platte Valley and the altitude of 6,000 feet is represented by the Saratoga experiment farm of 40 acres, under the Hugus-Mullison-Beale Ditch and the Davis-Folsom Canal, in Carbon County, donated by the Saratoga Improvement Company and the Saratoga Land and Irrigation Company. The northern part of the State and the altitude of 4,000 feet is represented by the Sheridan experiment farm of 50 acres, under irrigation, in Sheridan County, and donated by its citizens. Northeastern Wyoming, with the greatest rainfall and the altitude of 4,500 feet, is represented by the Sundance experiment farm of 49 acres, to be carried on without irrigation, in Crook County, and donated by its citizens. Southeastern Wyoming, the Sybille Valley, and the altitude of 5,000 feet, is represented by the Wheatland experiment farm, under Ditch No. 2, of the Wyoming Development Company, in Laramie County, being donated by that company.

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* Fodringsforsoeg med Svin, 1887.

Farm work in progress, D. McLaren, M. S. (pp. 6–9).

To facilitate the planting and measurement of crops and the keeping of accurate records, a forty-acre tract on each of the experiment farms has been divided into 36 one-acre plats, separated by crossroads, which, with the surrounding road, occupy the other 4 acres. These 36 one-acre plats have the same numbers and subdivisions as the 36 sections in a United States Government township.

Each of the forty-acre tracts has been plowed, and fenced with barbed-wire. The staple crops in many varieties have been planted on each. On the Wyoming University experiment farm at Laramie 6 acres are planted with cereals, 1 acre with potatoes, 1 with field peas, 1 with sugar beets, 1 with sorghum and corn, 1 with turnips and carrots, and 5 with grasses and forage plants, all in many varieties, for tests and for distribution among the farmers of Wyoming. Similar crops are planted on each of the experiment farms. At the Lander experiment farm, fruit and forest trees are planted. Aërial irrigation will be tested on the Saratoga experiment farm. At the Sheridan, Sundance, and Wheatland experiment farms extensive trials of field corn are being made. The crops on the Sundance experiment farm will not be irrigated, as that region receives the greatest rainfall.

In coöperation with the Department, the station has undertaken experiments with grass and forage plants grown without irrigation The aim is to find species of grass or methods of treatment that will benefit the large tracts of grazing land in the State which are difficult to irrigate. They are conducted on 10 acres of land near the station, which represent the average soil and climate of the Laramie Plains. The following species have been planted:

Northern blue grass (*Poa nemoralis*), orchard grass (*Dactylis glomerata*), switch grass (*Panicum virgatum*), Northern hair grass (*Aira cæspitosa*), scarlet clover (*Trifolium incarnatum*), alsike clover (*T. hybridum*), alfalfa (*Medicago sativa*), white sweet clover (*Melilotus alba*), esparcet or sainfoin (*Onobrychis sativa*), Northern lupine (*Hedysarum coronarium*), land clover (*Anthyllis vulneraria*), *Galega officinalis*, burnet (*Poterium Sanguisorba*), Indian millet (*Panicum miliaceum*), rescue grass (*Bromus schraderi*), wild chess (*B. inermis*), tall fescue (*Festuca elatior*), rye grass (*Lolium perenne*), canary grass (*Phalaris arundinacea*), Guinea corn (*Sorghum vulgare*, var. *cernuum*).

"For comparison and test 3 acres of prairie on the Wyoming University experiment farm are sowed with the same grasses, and will be irrigated. Five other acres of prairie will be flooded to test the effect of irrigation on the natural grass." Experiments will be tried with reference to the retention of moisture in the soil as affected by certain alkalis, gypsum, native phosphates, nitrates, and other fertilizers, and the waste products of glass and soda works.

Proposed work in horticulture, B. C. Buffum, B. S. (pp. 9–15).—Work in landscape gardening and with vegetables and fruits has been begun. The comparative vitality of Northern-grown (Minnesota) and Colorado seeds will be tested in field experiments. Varieties of grasses and forage plants, native and imported, will be tested under irrigation. A number of species of native grasses growing at the station or elsewhere in Wyoming are mentioned. It is hoped that a

thorough botanical survey of the State may be made. The irrigation equipment of the station is briefly described.

Geology of the Laramie Plains, J. D. Conley, Ph. D. (pp. 15–18).—A brief account of the geology of this region, from which the following is taken:

In giving the geological horizon of the Wyoming University experiment farm, grass fields, and garden the writer is at variance with the United States geological maps, which place the Laramie Plains in the Dakota Group.

From a study of excavations made in the city of Laramie and of the red sandstone quarries to the north it is certain that Laramie and the grass fields are in the Triassic formation. The red sandstone strata dips about 30 degrees to the west, passing beneath the Big Laramie River at the experiment garden, and must be several thousand feet beneath the surface at the experiment farm, 2 miles to the west. * * * Some Middle or Upper Cretaceous fossils are found 25 miles north of Laramie, and also in the Laramie Group, 20 miles to the northwest. At the latter point a stratum of coal dips northwest toward the foothills. The crest and southeast side of the mountain, of which the Laramie Group was once the northwestern slope, seems to have been carried away. This mountain must have extended to within a few miles of the experiment farm, at which point another mountain probably rose to the east, the west slope of which was covered by the Laramie Group, conformable with the Cretaceous and Triassic beneath. The latter mountain has also been torn down by the hand of time, laying bare the Cretaceous formation, whose crumbling and disintegrated rocks, mixed with local drift gravel, form the soil of the experiment farm.

Note on soil analysis, J. D. Conley, Ph. D. (p. 18).—Analyses of soils from each of the station farms will be published in a future bulletin. The following brief general statement is made regarding the soil of the station farm at Laramie:

"There is enough alumina in the soil at the Wyoming University experiment farm to give it body and a good consistency. It is a light, sandy loam, possessing enough of the essential ingredients for the native grasses to thrive well under irrigation alone. On a neighboring ranch in similar soil, the blue joint (*Agropyrum glaucum*) has produced 1½ tons per acre."

Flora of the Wyoming University experiment farm, A. Nelson, M. S. (pp. 18–21).—This is a brief preliminary report on a few species of the plants found growing wild on the station farm. The following species are described: *Townsendia sericea*, *Phlox cæspitosa*, *P. douglasii*, *Echinocactus simpsoni*, *Œnothera cæspitosa*, mountain lily (*Leucocrinum montanum*), plantain (*Plantago eripoda ?*), *Opuntia rafinesquii*, Rocky Mountain bee plant (*Cleome integrifolia*), *Malvastrum coccineum*, yarrow (*Achillea millefolium*), golden-rod (*Bigelovia graveolens*, var. *albicaulis*), thistle (*Cnicus scariosus*), wormwood (*Artemisia pedatifida ?*), larkspur (*Delphinium azureum*).

Weather report for April and May, 1891, A. M. Sawin, M. S. (21–23).—A tabulated record of temperature and precipitation for April and the first 15 days in May, 1891, prepared by Dr. L. S. Barnes, of Laramie.

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF STATISTICS.

REPORT NO. 85 (NEW SERIES), JUNE, 1891 (pp. 241–302).—This includes articles on the acreage of cotton, wheat, oats, barley, and rye; the condition of these and other crops, including fruit; official statistics of foreign crops; the agriculture of Chili; European crop report for June; and the freight rates of transportation companies.

DIVISION OF ENTOMOLOGY.

INSECT LIFE, VOL. III, NOS. 9 AND 10, JUNE, 1891 (pp. 359–432).—The principal articles in this double number are a Report of a Discussion on the Gypsy Moth (*Ocneria dispar*) at a conference held at Boston, Massachusetts, March 4, 1891; abstract of a paper on the Ravages of *Liparis* (*Psilura*) *monacha* in Germany and Means of Defense, by B. E. Fernow, read before the Entomological Society of Washington, March 5, 1891; A New Scale Insect (*Lecanium pruinosum*, n. sp.) from California, by D. W. Coquillett; Notes on the Habits and Earlier Stages of *Cryptophasa unipunctata*, Don., in Australia, by H. Edwards; Steps Toward a Revision of Chambers's Index, with Notes and Descriptions of New Species (continued), by Lord Walsingham; Description of Certain Lepidopterous Larvæ (*Pholisora hayhurstii*, *Triptogon imperator*, *Orgyia definita*, and *Apatela tritona*), by H. G. Dyar.

BULLETIN NO. 23.

OBSERVATIONS AND EXPERIMENTS IN THE PRACTICAL WORK OF THE DIVISION (pp. 83).—This includes the reports of the six permanent field agents of the Division for 1890, a brief summary of which was published in the Report of the Secretary of Agriculture for 1890, pp. 261–264.

Nebraska insects, L. Bruner (pp. 9–18).—Brief notes on the prevalence in Nebraska in 1890 of the corn root worm (*Diabrotica longicornis*), cutworms, corn ear worm (*Heliothis armigera*), codling moth (*Carpocapsa pomonella*), green-striped maple worm (*Anisota rubicunda*), and locusts or grasshoppers; and a list, with brief notes, of sixty-four species of insects which have attacked sugar beets in Nebraska. Spraying with arsenites or kerosene emulsion is an effective means of repressing most of these insects.

Various methods for destroying scale insects, D. W. Coquillett (pp. 19–36).—Accounts of experiments with hydrocyanic acid gas for the red scale (*Aonidia aurantii*, Maskell); with washes of resin, caustic soda and fish oil, and of lime and sulphur, singly or together, or combined with salt, for the San José scale (*Aspidiotus perniciosus*, Comstock); and with corrosive sublimate, glue, or aloes for different species of scales. The simplified tents used in the hydrocyanic acid gas treatment are described. It has been found that orange trees are less liable to injury by the gas when treated at night. The resin wash was found to be a very effective as well as inexpensive remedy for the San José scale. Glue gave good results, but is comparatively costly.

Experiments with resin compounds on Phylloxera, and general notes on California insects, A. Koebele (pp. 37–44).—Experiments with various resin washes for the *Phylloxera* in Sonoma Valley, California, are reported. The most satisfactory formula is caustic soda (77 per cent) 5 pounds, resin 40 pounds, and water to make 50 gallons:

> First the soda should be dissolved over fire with 4 gallons of water, then the resin added and dissolved properly, after which the required water can be given slowly while boiling to make the 50 gallons of compound. This will make 500 gallons of the dilnent, sufficient for 100 plants, and costing about 84 cents.

Observations are also reported on several species of the genus *Clisiocampa*, a noctuid larva (*Tæniocampa*) which injures fruit trees, *Caloptenus devastator*, and *Camnula pellucida*.

Entomological notes for the season of 1890, *M. E. Murtfeldt* (pp. 45–56).—Notes are given on the prevalence in Missouri of chinch bugs, cankerworms, cutworms, *Gortyna nitela*, *Heliothis armigera*, *Phyllotreta vittata*, *P. sinuata*, *Chætocnema pulicaria*, *Conotrachelus nenuphar*, plant lice, *Parasa chloris*, *Euclea querceti*, *Empretia stimulea*, *Phobetron pithecium*, *Limacodes scapha*, *Lagoa crispata*, *Saturina io*, *Datana angusii*, *D. ministra*, *Orgyia leucostigma*, *Ichthyura inclusa*, and *Hyphantria cunea*. A carabid beetle (*Plochionus timidus*) was observed to prey extensively on the fall webworm (*Hyphantria cunea*). Four new enemies of the apple are described, *Penthina chionosema*, *Proteopteryx spoliana*, *Steganoptycha pyricolana*, and *Gelechia intermediella* (?).

Under the head of experiments with insecticides are given accounts of experiments with X. O. dust, buhach, arsenites of ammonia, and petroleum sludge. It was found that dry X. O. dust blown from a bellows during the middle of the day is a thoroughly satisfactory remedy for plant lice of all kinds. The arsenites of ammonia, when used according to the manufacturer's directions, one tablespoonful to a gallon of water, proved to be an efficient insecticide, but badly scorched the leaves of peach and cherry and slightly damaged the foliage of plum, apple, rose, and squash. The petroleum sludge arrived too late for satisfactory trial, but Miss Murtfeldt thinks that its intolerable and persistent odor is a serious obstacle to its general use, especially in small gardens.

Work of the season, H. Osborn (pp. 57–62).—Notes on the following insects observed in Iowa in 1890: *Crambus exsiccatus*, leaf hoppers (*Jassidæ*), grasshoppers and crickets in grass, *Pempelia hammondii*, *Papilio turnus*, *Selandria cerasi*, *Datana ministra*, *Diabrotica longicornis*, *D. vittata*, *D. 12-punctata*, *Lophyrus abbotii*, and *Trichobaris trinotatus*. The last two are new to the State. Successful tests of arsenite of ammonia as an insecticide are also reported.

Some of the insects affecting cereal crops, F. M. Webster (pp. 63–79).—This relates largely to experiments and observations during more than 6 years, with reference to the number and development of broods of the Hessian fly, chiefly in Indiana. It was found that throughout Indiana this insect is double-brooded. The article also contains observations on the effect of the larvæ on the plants, especially on the color, and on the effect of the weather in the development of the full brood, together with a résumé of preventive and remedial measures.

BULLETIN NO. 25.

DESTRUCTIVE LOCUSTS, C. V. RILEY (pp. 62, plates 12, figs. 11).—A popular account of the geographical distribution, destructive appearances, life history, and habits of the following species of injurious locusts found in the United States: Rocky Mountain locust (*Caloptenus spretus*), lesser migratory locust (*C. atlantis*), non-migrating red-legged locust (*C. femur-rubrum*), California devastating locust (*C. devastator*), differential locust (*C. differentialis*), two-striped locust (*C. bivittatus*), pellucid locust (*Camnula pellucida*), and American acridium (*Schistocerca americana*). The remedies and devices for the destruction of locusts are described and discussed. The bulletin is illustrated with a map of the United States, showing the distribution of the Rocky Mountain locust, and various kinds of apparatus used in the repression of locusts are shown.

CIRCULAR NO. 2 (SECOND SERIES), JUNE, 1891.

THE HOP PLANT LOUSE (pp. 7, plate 1, figs. 5).—A popular account of the life history of *Phorodon humuli*, with suggestions regarding remedies, and descriptions of spraying apparatus, prepared in view of the appearance of this insect in alarming numbers in New York, Oregon, and Washington. Reference is made to the record of investigations of this insect in the Annual Report of this Department for 1888. The remedies recommended are, (1) spraying with kerosene emulsion or fish-oil soap in the spring, or preferably in the fall after hop picking; (2) the destruction of all wild plum trees in the hop-growing regions; (3) the burning or drenching of the hop vines with kerosene emulsion soon after the crop is harvested.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

The function of the root tubercles of leguminous plants.—A review by H. W. Conn.—The function of the root tubercles has been as much discussed as their nature and structure.* At first they were regarded as purely parasitic and therefore injurious rather than beneficial to the plant. It was soon found, however, that they contained an unusually large amount of nitrogenous matter,† and they were for a time supposed to be reservoirs of compounds of nitrogen.‡ It was next discovered that the plants possessing root tubercles contained more nitrogen than those without them, and it was thought that in some way they enabled the plants to obtain an extra amount of nitrogen from the deeper layers of the soil.§ To-day it is pretty definitely proved that they have some connection with the power possessed by legumes of acquiring atmospheric nitrogen.

It is only within recent years that plants have been known to acquire nitrogen in large quantities from the air. The classical experiments of Boussingault, Lawes, Gilbert, and Pugh were for a time thought to prove that plants do not possess this power. In 1881, Atwater instituted a series of experiments, which were repeated in 1882, and brought positive evidence of the acquisition of large quantities of nitrogen from the air by peas during their period of growth. He concluded that it was extremely probable, though not absolutely certain, that the free nitrogen of the air was thus assimilated. Later experiments revealed large losses of nitrogen during germination and early growth. In the accounts of these investigations it was urged that this loss of nitrogen was probably caused by microbes; that it helped to explain why previous experimenters had failed to find proof of the acquisition of atmospheric nitrogen by plants, especially legumes, but that the negative results obtained by the latter were also due to the exclusion of the action of electricity or microbes, by which the assimilation of

* For a résumé of recent research on the nature of root tubercles, see Experiment Station Record, vol. II, p. 686.

† de Vries, Landw., Jahrb. 6, (1877).

‡ Schindler, Jour. f. Landw., 33 (1885); Brunchorst, Ber. d. bot. Ges., 3 (1885).

§ Ward, Phil. Trans. Roy. Soc., 1887.

atmospheric nitrogen might be aided.* Other experimenters, including Hellriegel and Wilfarth, Wolff, Bréal, and Lawes and Gilbert, have since verified the conclusions thus reported in 1881–84. To day it is generally accepted that legumes at least acquire large amounts of atmospheric nitrogen. The leaves perhaps may be unable to absorb this element from the air, but the indications have been growing that the roots of the plant do in some way obtain large quantities of nitrogen from the atmosphere.

The relation of the root tubercles to the acquisition of atmospheric nitrogen was first suggested by Hellriegel, who was aided in his work by Wilfarth. Their results were published in two papers.† Hellriegel found that the Gramineæ and the Leguminoseæ differ radically from each other in their relation to nitrogen. The former can not flourish in a soil devoid of nitrogenous compounds. For a short time they grow readily enough, but as soon as the material supplied in the seed is used up the plants begin to turn yellow, become stunted, and never show any increase in nitrogen over that contained in the seed. They are, in fact, nitrogen-starved, for if nitrogen is added to the soil at the time that the starvation period begins, a recovery takes place. The Gramineæ are unable to make use of atmospheric nitrogen. With the leguminous plants, different results were obtained. In experiments with peas, Hellriegel verified previous observations by finding that these plants do undoubtedly gain nitrogen from the atmosphere. He observed that when they were grown in soils consisting of pure quartz sand thoroughly freed from nitrogen compounds, and fed with materials containing no nitrogen, the plants flourished and eventually showed a considerable increase in nitrogen. In the growth of these plants in nitrogen-free soil he found two marked stages. The development is rapid at first, and continues until the reserve material in the seed is exhausted. Then there occurs a somewhat sudden cessation of growth, similar in character to the starvation period observed in Gramineæ.

In the case of the legumes, however, the plant soon recovers; its leaves turn green again, the growth goes on in a normal manner, and final analysis shows that nitrogen has been accumulated. Considerable variation was noticed in the growth of plants under these conditions, even though all were treated seemingly alike. Of two plants growing side by side, one was sometimes vigorous and the other dwarfed and stunted. The vigorous plants all had tubercles on their roots, while the others either had none or relatively few. The recovery of the plants

* The results of the experiments of the first series were briefly reported at the meeting of the American Association for the Advancement of Science in 1881; those of the first and second series together were reported at the meetings of the British and American Association for the Advancement of Science in 1884, and in detail in the American Chemical Journal, vol. VI, p. 365, and those of the later series in the same journal, vol. VIII, pp. 327 and 398.

† Tagebl. d. 59 Versamml. deut. Natur. fu. Aerzte, Wiesbaden, 1887, and Zeitsch. d. Ver. f. Rübenz. Ind. d. d. R., 1886 and 1888.

from the first period of nitrogen starvation was observed to be closely connected with the growth of the tubercles, and the inference was drawn that the cause of the renewed vigor of the plants was to be found in the root tubercles. Thinking that microörganisms in the soil might in some way be connected with this process, Hellriegel cultivated peas in soils which contained no nitrogen, but which were watered with a soil infusion. This infusion was made by shaking in water soil from a fertile field, and then allowing it to settle. The water thus treated, he argued, would contain whatever organisms there might have been in the soil, and if the production of the tubercles and the fixing of nitrogen by plants in nitrogen-free soil was due to the action of these organisms, plants watered by such an infusion ought to indicate it. The results were very striking. All of the peas watered with soil infusion showed a vigorous growth, an increase in nitrogen, and numerous root tubercles. Those not thus inoculated showed wide variations from vigorous growth to complete failure to recover from the starvation period. To make the result more positive, peas were cultivated in nitrogen-free soils which had been sterilized by heat. In this case no recovery from the starvation period occurred unless the plants were first treated with the soil infusion. Finally it was proved that the soil infusion was powerless to produce any effect if it was first sterilized by heat.

From these results of Hellriegel's investigations the conclusion was warranted that leguminous plants in some way acquire the power of assimilating nitrogen from the atmosphere, but that this power does not inhere in the plants themselves. In order that they may make use of the nitrogen in the air, it is necessary that certain organisms in the soil should penetrate into their roots. These organisms growing in the roots of the legumes produce the root tubercles, and in some way enable the plants to assimilate atmospheric nitrogen. Under ordinary conditions these microörganisms are freely supplied to the plant from the soil, but in the culture experiments cited above in order to make sure that they would be present, the plants were inoculated with an aqueous infusion prepared from a rich soil.

Two other points of significance were brought out by Hellriegel: (1) If plants were grown in soils containing nitrogen, they could assimilate this equally well whether root tubercles were present or not, thus indicating that the tubercles are not necessary to the assimilation of soil nitrogen. (2) Different species of legumes seemed to have different species of tubercle microörganisms associated with them, for it was found that while soil in which peas had been growing might be well adapted to produce the necessary tubercles in other pea plants, it might not produce them in other species of legumes.

These surprising results of Hellriegel's inquiries led to other experiments on the functions of the root tubercles and the power of plants to assimilate atmospheric nitrogen. Hellriegel's general results have been confirmed by several observers, among whom may be mentioned Frank, Prazmowski, Atwater and Woods, Lawes and Gilbert, Beyerinck and

Laurent. But although, as will be seen below, there is a consensus of all experimenters as to the general relation of the tubercles to the assimilation of nitrogen, the differences regarding details lead to almost diametrically opposite views as to the interpretation of the phenomena. The most important of the recent publications on this subject are those of Frank and Prazmowski. These observers have been working for several years and have each published several papers. In 1890 each published a long account of the results of his previous work, and with it a summary of his views on the whole question. These two papers were published so nearly at the same time that neither contains any reference to the other. A review of these two papers will give us the best outline of the present condition of the discussion.

The extensive investigations of Frank* were carried on with several species of legumes which he cultivated in pots containing soils of various kinds. In one series a nitrogen-free soil and in a second series a rich humus was used. Sterilization of the soils was accomplished by heating, and he admits that the heat produced various chemical changes, especially in the humus, which interfered with the success of his experiments. His results indicated that legumes do gain nitrogen from the air and that the power in some cases at least is connected with the formation of root tubercles. According to his experiments, however, different species of legumes differ in this respect. Beans, for example, show no greater amounts of nitrogen when tubercles are present than when they are absent. For such plants the tubercle is to be regarded simply as a parasite. In the case of the lupine and the pea, the tubercles are of more value. Of course none of these plants grow vigorously in nitrogen-free soil under ordinary conditions, but when they are provided with the tubercle organism their growth is more vigorous, they develop more leaves, and they assimilate more carbon and more atmospheric nitrogen. But according to Frank even these plants gain no advantage from the tubercles if they are growing in rich soil. When growing in soil containing nitrogen they have no need of the microbes, being able to assimilate plenty of nitrogen without them. Plants grown in the rich humus used in some of his experiments showed an equal growth and fixation of nitrogen whether they developed tubercles or not. In some experiments plants without tubercles actually developed better than those with tubercles, a fact which he thought might be explained by the injurious action of the sterilization on the chemical condition of the soil. Frank concluded then that under ordinary conditions the tubercles are of no use to the plant. But when the plants are growing in poor soil, and especially in one lacking in nitrogen, they have not of themselves sufficient vigor to develop and assimilate nitrogen from the air. The microbes of the tubercles under these conditions serve as a stimulant to the plant. Under their influence the plant takes on new vigor, grows normally, and assimilates nitrogen from the only possibly source—the air.

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*Landw. Jahrb., 1890, pp. 523-640.

Frank does not think, however, that the tubercle organism is itself the agent of the assimilation of nitrogen. This power belongs to the plant and the presence of the microbe simply stimulates the plant to greater growth in poor soils, and hence indirectly increases its power of assimilating nitrogen. In his experiments he found that the whole activity of the plant was stimulated by the presence of the microbe, its growth including its development of chlorophyl, and its assimilation of carbon as well as of nitrogen. He urges that other plants besides legumes have the power of nitrogen assimilation, though perhaps in less degree. Even some algæ, he thinks, can do this. He claims further that his experiments show that the legumes can assimilate atmospheric nitrogen even when they are free from tubercles. This they can not do readily in poor soil, since their general vigor is here too small, but in rich soils they do assimilate great quantities of nitrogen and he thinks that they get it from the air. Moreover the cultivation of the tubercle organism in artificial culture does not indicate that it can nourish itself on atmospheric nitrogen. For these reasons he concludes that there is no ground for attributing the nitrogen assimilation solely to the microbe, but that it is really a property of the plant, stimulated to excess in certain cases by the presence of the microbe. While then the tubercle organism is of value for certain species of legumes growing in poor soil, it is of no value in rich soils, and for certain species it is of no value at all. He found no reason for believing that different species of tubercle organisms were associated with different species of legumes, and concluded that in ordinary soils in which legumes had been growing the microbe was present in sufficient quantities to produce an abundance of tubercles.

Prazmowski* has reached somewhat different conclusions. His experiments were fewer in number, but were performed with greater precautions against accidental errors. The plants were all grown in specially prepared vessels, so arranged that the contents could not come in contact with any air that had not first been filtered through cotton to deprive it of germs. The stem of the plant protruded through a specially guarded opening in the top of the vessel, and the leaves were thus exposed to the air. In the globe-shaped culture vessel he placed sand which had been most thoroughly purified of all traces of nitrogenous matter by washing, and freed of all microbes by sterilizing at a high heat. All water used in the culture was conducted to the bottom of the vessel by a sterilized glass tube, so arranged as to prevent the possibility of contamination by bacteria from the air. Into this vessel of purified sand he introduced solutions containing the plant foods with which he wished to experiment, and thoroughly sterilized the whole apparatus by heat. He then introduced a germinating seedling, using all antiseptic precautions. During the experiment he caused a stream of filtered air to pass through this soil, and all water used was thoroughly

* Landw. Vers. Stat., 38 (1890), pp. 5–62; Experiment Station Record, vol. II, p. 686.

sterilized. In this way he reduced the possibility of the influence of the contaminating microbes to the lowest terms. After the experiment he made an examination of his soils to see if he had succeeded in preventing the access of contaminating organisms. In most of his experiments this had not been accomplished, but some of the soils did appear sterile, even after the plants had been growing for weeks, and the results of these experiments did not differ from the others. A special advantage of this method of experimenting was in his knowing exactly what his plants had to feed upon, thus avoiding all errors produced by rain or dust or from unknown constituents in his soils. The great value of his experiments, therefore, lay in his so controlling all of the conditions that he could directly determine the action of the tubercle organism.

Prazmowski's experiments comprised four series: (1) Plants grown in sterilized soil, fed with nitrogen-free food, and watered with sterilized water; (2) plants grown in sterilized soil, fed with nitrogen-free food, and watered with a water which contained some of the tubercle microbes obtained from pure cultures of these organisms; (3) plants grown in soils supplied with calcium nitrate, in addition to other salts, and watered with sterilized water; (4) plants grown in soils with the nitrogen ration and watered with water containing the tubercle microbe. The results in all his experiments were uniform. In all cases where the microbe was added in the water, tubercles developed, the plants were vigorous, and showed by final analysis an increase of nitrogen. In the nitrogen-free soils watered with sterile water, there were no tubercles and no increase in nitrogen over that contained in the seed, while the inoculated plants in the same soils all showed an increase of nitrogen, sometimes as much as sixfold. In plants fed with a nitrogen ration there was in all cases an increase in nitrogen, but the inoculated plants always showed a greater increase than those not inoculated.

Prazmowski also carried through a series of experiments with water cultures, but with less success. In water cultures containing no nitrogen he found exactly the same results as in his soil cultures. But the plants which he grew in water cultures containing a nitrogen ration and inoculated with the tubercle organism, did not do so well. Some injurious disease affected them (there were only two experiments) and prevented their normal growth. Their leaves turned yellow and they did not develop tubercles in the normal manner, although inoculated with the tubercle organism several times. As was to be expected, when analyzed these plants showed less nitrogen than the inoculated plants which developed normally on the nitrogen ration.

Prazmowski does not think it has yet been positively determined whether the nitrogen fixed by these plants is derived from the free nitrogen of the air or from some form of combined nitrogen, though he regards it as much more probable that it is the free nitrogen. Hellriegel's experiments have shown that the legumes can gain nitrogen

when supplied with air deprived of ammonia and nitric acid. He repeated the experiments of Boussingault in confined air with the exception that he inoculated his plants. This difference changed the result from negative to positive, and showed that with the aid of the microbes, legumes did obtain nitrogen from the air when ammonia and nitric acid were absent.

Admitting this conclusion, Prazmowski sees three possible methods by which the organisms produce their effect on the plant: (1) The bacteria may produce certain substances (ferments ?) by the aid of which the plant is able to fix free nitrogen in a compound which the plant incorporates into its own substance; (2) the bacteria themselves may seize upon the nitrogen and incorporate it in compounds in their own bodies and then the plant may make use of the bacteria for food; (3) the assimilation of nitrogen may be a function of the combined life of the plant and the microbe acting together, the necessary energy being the result of their symbiosis. Of these three possibilities Prazmowski inclines to the second, thinking that the bacteria, after fixing the atmospheric nitrogen in their own bodies, under the influence of the plant tissue degenerate into bacteroids and are finally absorbed by the plant.

It will be seen that there are several points of difference between the views of Frank and Prazmowski. The most important is the claim made by Frank that the tubercles are of value to the plants only when growing in poor soil, while those plants which grow in rich soil gain an equal amount of nitrogen whether or not they are supplied with tubercles. Other more recent experiments do not confirm this conclusion. Atwater and Woods * have found that the tubercles do have a very important relation to the fixation of atmospheric nitrogen, even when nitrogen is supplied to the roots in the form of nitrates. Wilfarth † in a recent address criticises Frank's experiments as inexact and containing numerous sources of error. He thinks that the experiments by which Frank undertook to prove that other plants beside legumes can fix nitrogen, are unsatisfactory, the amount of nitrogen acquired by the plants being within the limits of error. Wilfarth also mentions further experiments of his own which directly contradict the claim of Frank, that the tubercles are of no value in rich soils, and promises soon a more complete description of these investigations.

Bréal ‡ made a study of the root tubercles—their composition, their formation through the agency of bacteria, the methods of inoculation, and the gain of nitrogen by legumes, peas, beans, and alfalfa in water, artificial soil and otherwise. He observed that inoculation could be readily brought about in the roots of legumes growing in water or in soil by piercing a root and inserting a portion of another root or other material containing bacteria; that cultures of the bacteria could be

* Am. Chem. Jour., vols. XII and XIII.

† Landw. Vers. Stat., 38, p. 322.

‡ Ann. Agron., 15 (1889), p. 529.

used for the inoculation; and that the plants thus inoculated and bearing root tubercles gained large quantities of nitrogen from the air.

Atwater and Woods* made some two hundred trials with oats, corn (maize), and peas in purified sand. In all cases mineral salts and in some cases nitrogen in the form of nitrates, were supplied in the nutritive solutions. In some cases aqueous infusions of the soil in which peas had grown were added to the solutions, in others not. Root tubercles appeared upon the peas, but not on the oats or corn. There was little apparent relation between the soil infusions and the number of root tubercles on the peas. Some of the plants had large numbers of tubercles, others did not, and this was true not only of the plants in different pots, but of the different plants in the same pot, and it was likewise the case whether the soil infusion had been applied or not. As the sand had been carefully washed and ignited at a high temperature, it was believed that bacteria or their spores were supplied from the air. Neither oats nor maize showed any gain of atmospheric nitrogen. With the peas, whenever the root tubercles were abundant the gain was large. Where there were no root tubercles there was generally a loss of nitrogen, and the amount of gain varied with the abundance of the root tubercles, both with and without nitrates in the nutritive solutions.

Lawes and Gilbert † describe several series of experiments undertaken for the purpose of verifying Hellriegel's results. They experimented with peas, red clover, vetches, blue lupines, yellow lupines, and alfalfa. Their plants were cultivated under three different conditions, (1) in washed sand and fed with no nitrogen; (2) in the same, but inoculated with a soil infusion; (3) in rich garden soil. Their results differed somewhat with the different species of legumes, but in general confirmed those of Hellriegel. The inoculated plants always developed tubercules and fixed nitrogen, while those uninoculated failed to do so with any regularity. They did not sterilize their soils and therefore found tubercles present in nearly all of their plants. Their results gave no indication as to whether the tubercles are of any value for the fixation of nitrogen by plants growing in rich soils. The conclusions of Lawes and Gilbert are especially interesting since their earlier work led them to deny the power of plants to fix atmospheric nitrogen.

More recently Laurent ‡ has again confirmed the conclusions as to the relation of tubercles to the power of nitrogen fixation. His work is chiefly confined to the study of the methods of growing the microbes, and his paper gives no results of analysis. He succeeded, however, in growing the plants successfully in water cultures and getting a luxuriant development of tubercles and a vigorous growth of the plants. A thorough aëration of the water was necessary for this purpose, and the lack of aëration is offered as the explanation of the failure of other

*Connecticut Storrs Station Bulletin No. 5 and Annual Report for 1889, and Am. Chem. Jour., *loc. cit.*

† Proc. Roy. Soc., 47 (1890), No. 1.

‡ Ann. de l'Inst. Pasteur, 1891, pp. 105–140.

investigators. Laurent further finds that the tubercle organism can be cultivated successfully in solutions containing no nitrogen, thus confirming results which had previously been obtained by Prazmowski and Bréal, and adding a significant fact to our knowledge of the relation of these microbes to atmospheric nitrogen. Although the tubercle organisms certainly grow in nitrogen-free solutions, Laurent has as yet been unable to show by analysis that they actually fix nitrogen from the air, on account of the small amount of nitrogen present in such cultures.

Summary.—From this brief review it will be seen that our present knowledge of the functions of the root tubercles is somewhat as follows:

(1) The tubercles are produced by organisms which ordinarily live in the soil, especially in soils in which legumes have previously been grown. It is not yet definitely determined whether different species of microbes are associated with different species of legumes.

(2) The tubercles are undoubtedly in some way connected with the power of the plant to acquire nitrogen from the atmosphere. Their presence enables the legumes to accumulate nitrogen when growing in a nitrogen-free soil, and probably increases the nitrogen assimilation in all soils.

(3) The nitrogen assimilated comes from the atmosphere. In all probability the free nitrogen of the air is thus assimilated.

(4) It has not yet been determined whether the microbe itself derives the nitrogen from the air and is then used by the plant for food, or whether the power of assimilating nitrogen belongs to the plant and is only stimulated by the microbe, or whether this power is a function of the combined life of the two organisms growing together.

New experiments concerning the assimilation of nitrogen by plants, B. Frank and R. Otto (*Deut. landw. Presse*, 18 (1891), *p.* 403).—Determinations of the nitrogen in the leaves of red clover, lucern, wood pea, cole rape, hemp, grape, caraway, and yellow lupine, collected from growing plants in the morning and in the evening and immediately dried at 60° C., showed the leaves collected in the evening to be richer in nitrogen in every case than those collected in the morning. The difference was most prominent in the cases of lucern, red clover, and wood pea. The percentages of nitrogen found in the leaves of these plants, calculated for dry matter, are given as follows:

	Evening.	Following morning.
	Per cent.	*Per cent.*
Red clover	2.087	1.486
Lucern	4.382	2.906
Wood pea	4.124	3.088

In other experiments the influence of sunlight on the nitrogen content of leaves after cutting, was observed. Leaves of red clover and yellow lupine were gathered in the morning, and while a part of them were dried immediately at 60° C., the remainder were placed with their stems

in distilled water and exposed to the sunlight during the day. On analysis it was found that the leaves exposed to the sunlight during the day contained more nitrogen than those dried as soon as gathered. Since the cut leaves had no connection with the plant, the increased nitrogen must have been derived through other means than the roots.

A difference was also noticed in the percentage of asparagin in the water-free leaves of red clover gathered in the morning and in the evening:

Evening, June 9	per cent asparagin	0.973
Morning, June 10	" " "	0.277

The authors believe these results merit the conclusion that green fodders, as red clover for instance, should be cut in the evening soon after sundown to secure the greatest food value, and that likewise the food value of pasturage is greatest at this time, especially if the day has been bright and warm.

Relation of climatic conditions to the formation of nicotine in tobacco, Adolf Mayer (*Landw. Vers. Stat.*, 38, *pp.* 453–467).—In experiments recently published the author pointed out the influence of fertilizing materials on the quality of tobacco, and showed with reference to nicotine that its formation in the plant was favored by a heavy application of easily available nitrogenous materials, and that a high percentage of nicotine was in no instance observed where the supply of plant food was deficient (see *Landw. Vers. Stat.*, 38, *p.* 92, or Experiment Station Record, vol. II, p. 457).

The author calls attention to the well-known fact that young plants and the younger parts of the plant in general contain a comparatively small amount of nicotine; also that plants which are not topped (seed plants) are comparatively poor in nicotine.

To further study the conditions of growth favorable to the development of this alkaloid, experiments were made in 1890 with reference to the influence of light, heat, soil water, and the humidity of the atmosphere. The author states at the outset that the effects of individuality on the formation of nicotine in tobacco are quite strong. To study the effects of temperature, plants treated otherwise the same, were grown in different cases out of doors, in a greenhouse with southern exposure, and from seed sown late in the season, so that the plant developed at a relatively low temperature. As the days were shorter the plants of the last series naturally received less light than the others. The first two series were harvested August 18 to 20; the last, November 11. The average amount of dry matter contained in the leaves per plant and the average percentage of nicotine are given for the different conditions as follows:

	Dry matter.	Nicotine.
	Grams.	*Per cent.*
Grown at low temperature (planted late)	22.5	2.1
Grown at medium temperature (in open air)	30.9	3.0
Grown at high temperature (in greenhouse)	32.5	4.1

The elaboration of nicotine, according to these figures, increased regularly with the increase in temperature.

The effect of light was observed by comparing the development of nicotine in plants grown in the sunlight with that of those shaded on all sides except the north side, thus receiving no direct light, or those grown in the sunlight but having a number of leaves covered with tin foil. Plants grown under these different conditions contained the following percentages of nicotine:

	Per cent.
Grown in full direct sunlight	2.9 4.9
Grown in shade	1.5 2.2
Leaves fully exposed to light	No. 1..4.4 No. 2*.0.6
Leaves of same plants shaded	No. 1..2.2 No. 2..0.35

Although the variations in nicotine content were quite large in plants receiving like treatment, the differences in this respect between plants receiving unlike treatment were greater, and indicate that direct sunlight had a favorable influence on the formation of nicotine, and further, that this effect is to a considerable extent local, since the leaves exposed to the sunlight produced twice as much nicotine as those on the same plants which were shaded. The author has shown on previous occasions that tobacco rich in nicotine is in general dark colored. He suggests that since the production of nicotine is favored by light, it may be possible to produce relatively light or dark leaves by cultivating the plants close together or farther apart.

To study the effects of water in the soil, an attempt was made to supply respectively 80, 60, and 40 per cent of the amount of water by weight which the soil was capable of absorbing, and though rains prevented this plan from being accurately carried out, these conditions of soil moisture were approximated. The plants grown under the different conditions contained the following percentages of nicotine:

Percentages of nicotine.

	Water in large excess.		Water in excess.		Kept as dry as practicable.			
	Plant 1.	Plant 2.	Plant 3.	Plant 4.	Plant 5.	Plant 6.	Plant 7.	Plant 8.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nicotine	1.20	1.05	1.75	1.45	3.10	2.90	3.10	2.70

The plants receiving the largest quantity of water produced the least dry matter, and those which were protected from the rain and kept quite dry, the most dry matter. The production of organic matter and of nicotine was thus hindered by the presence of large quantities of water in the soil. These results, in the opinion of the author, corroborate

* Harvested one month earlier.

statements previously made, that in general any factor which hinders the vigorous development of the plant is likewise disadvantageous to the formation of nicotine.

Variation in the transpiration of the plants was brought about by covering a number of plants with glass cases closed on all sides, that is, increasing the humidity of the atmosphere, while others were grown in the open air and allowed to transpire naturally. The results follow:

		Per cent nicotine.
Unhindered transpiration	Plant 1..	3.10
	Plant 2..	2.90
Transpiration artificially diminished	Plant 3..	3.20
	Plant 4..	3.55

Since in hindering the transpiration the temperature was raised and heat has been shown to be favorable to a high nicotine content, it seems quite doubtful if any good effects are to be attributed to the diminishing of the transpiration.

The results of the investigation seem to point to the fact that heat, light, and a comparatively dry rather than an excessively moist soil are favorable to the formation of nicotine, and that the effect of these factors on the nicotine content is more marked than on the total organic matter of the plant.

Increase of the fat content of milk by feeding cocoanut cake, R. Heinrich (*Landw. Ann. d. meck. pat. Vereins*, 1891, *pp.* 65–72).—Two experiments to compare the effect of cocoanut cake and peanut cake on the fat content of milk, were made under the direction of the author in 1889 and 1890 at the experiment station at Rostock, Germany. The first experiment was made with two Breitenburg cows which had calved in February, 1889, and lasted from June 1 to December 19, 1889. During this time 1 kilo of peanut cake or 1.5 kilos of cocoanut cake per day were fed with a basal ration composed of rye meal, hay, oat straw, and beet leaves or beets, and which remained as nearly as possible the same throughout the experiment. The cows were alternated from one ration to the other in periods of 3 weeks during the whole experiment, one cow receiving the cocoanut ration while the other received the peanut ration. The cocoanut ration was at all times slightly lower in protein but somewhat richer in fat and carbohydrates than the peanut ration. The milk was analyzed weekly. The average amount of butter fat produced per day by each cow on each of the rations was, from June 1 to December 7, as follows:

Butter fat produced per day.

	Cow No. 1.	Cow No. 2.
	Kilo.	*Kilo.*
On the peanut-cake ration	0.365	0.413
On the cocoanut-cake ration	0.366	0.456

The daily production of butter fat thus increased in the case of cow No. 2 when the cocoanut cake was fed. The author suggests that the absence of a similar increase with cow No. 1 may have been due to a dislike which it showed for the cocoanut cake. He further suggests that the favorable action of the cocoanut-cake ration may possibly have been caused by the slightly increased amount of protein which that ration contained.

A second experiment was made in 1890, in which the daily rations consisted of 2 kilos of peanut cake and 12.5 kilos of oat straw, or 5 kilos of cocoanut cake and 10 kilos of oat straw. Both rations contained the same amounts of dry matter, protein, and carbohydrates; but the cocoanut-cake ration contained 350 grams more fat than the other. These two rations were alternated as in the previous trial, the periods in 1890 being 4 weeks long instead of three, and the milk analyzed twice each week. The two cows fed in the previous experiment and a third cow which ate the cocoanut cake readily were used in 1890. The first two had calved in April and May, 1890, and the third had given milk for over 2 years. The experiment lasted from June 11 to August 29 with Nos. 1 and 2, and to December 19 with No. 3. The results are summarized as follows:

Percentages and total amounts of fat in milk.

	Percentage of fat.			Total amount of fat per day.			
	Morning.	Noon.	Night.	Morning.	Noon.	Night.	Total.
	Per cent.	*Per cent.*	*Per cent.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
No. 1. With cocoanut cake	3.49	5.39	4.39	239	174	179	592
With peanut cake	3.06	4.12	3.45	184	124	122	430
Increase on cocoanut cake	0.43	1.27	0.94	55	50	57	162
No. 2. With cocoanut cake	3.28	4.25	3.63	178	121	116	415
With peanut cake	2.47	3.28	2.71	158	102	90	350
Increase on cocoanut cake	0.81	0.97	0.92	20	19	26	65
No. 3. With cocoanut cake	3.41	5.02	4.21	119	94	81	294
With peanut cake	2.81	3.71	3.48	102	73	73	248
Increase on cocoanut cake	0.60	1.31	0.73	17	21	8	46

The results show that in these cases the fat of the milk was considerably increased, both in percentage and total amount, when the cocoanut-cake ration was fed, but they indicate a considerable difference in the animals regarding this point. No data are given as to the other constituents of the milk.

It is to be remembered that the cocoanut-cake ration contained 350 grams more fat than the other. The author states that the increased yield of butter fat might be accounted for by this increased amount of fat in the food, and he refers to recent experiments by Klein in Königsberg, which indicate that a part of the fat of the food may pass directly into the milk.

EXPERIMENT STATION NOTES.

ARKANSAS STATION.—R. L. Bennett, B. S., has been appointed director. The governing board at present includes J. T. Henderson, H. G. Bunn and B. C. Black.

COLORADO STATION.—F. J. Annis, M. S., is acting director and secretary; F. Huntley, B. S., assistant agriculturist; and F. C. Avery, treasurer.

CONNECTICUT STORRS STATION.—H. M. Smith has been appointed assistant chemist to the station vice H. B. Gibson, B. A., whose present address is Robert Schumann, Strasse 4 pt., Leipsic, Saxony.

INDIANA PURDUE UNIVERSITY.—The special bulletin on commercial fertilizers, issued May, 1891, by H. A. Huston, M. A., as State chemist, contains statements regarding the sources of the nitrogen, phosphoric acid, and potash in fertilizers, statistics regarding the commercial fertilizers sold in Indiana in 1890, directions for field experiments with fertilizers by farmers, and tabulated analyses of 143 samples of fertilizers.

"Twenty-nine thousand tons of commercial fertilizers were sold in the State during 1890. This contained 413 tons of actual potash valued at $49,600; 837 tons of ammonia valued at $301,120; 4,628 tons of phosphoric acid, of which 2,537 tons were 'available' and valued at $405,920 and 2,091 insoluble and valued at $125,460; making a total value of $882,100. Included in this are 9,550 tons of bone, raw and steamed, the actual selling price of which must have been not less than $300,000. The money actually expended for commercial fertilizers in Indiana during 1890 was less than 3 per cent of the value of the nitrogen, phosphoric acid, and potash that were exported from the State in corn and wheat alone during the same year."

MINNESOTA STATION.—Plans for a dairy building to cost $15,000 have been accepted, and it is expected that the building will be completed by November. T. L. Haecker has been elected instructor in butter making.

OKLAHOMA COLLEGE AND STATION.—The Agricultural and Mechanical College and Experiment Station for Oklahoma Territory have been located at Stillwater, Payne County. Two hundred and forty acres of land have been donated for the college and station, and the town of Stillwater has bonded itself for $10,000 for buildings. The board of directors organized June 23, 1891, includes Gov. George W. Steel, *ex officio;* Robert J. Barker, president; Amos Ewing, secretary; J. P. Lane, John Wimberly, and Arthur N. Daniels.

OREGON STATION.—G. W. Shaw has been elected chemist vice P. H. Irish, Ph. D.; E. R. Lake, M. S., is no longer a member of the station staff. The station bulletins will hereafter be printed at the station. Pig-feeding experiments are in progress, and experiments with wheat will be a prominent feature of the work of the station.

PENNSYLVANIA COLLEGE AND STATION.—J. B. Doyle, of Philadelphia, and Frank Knoche, of Harrisburg, have been elected members of the board of trustees vice J. A. Beaver and Cyrus Eox. J. W. Fields has been elected assistant chemist of the station vice H. B. McDonnell, M. D.

UTAH STATION.—Dynamometer tests of mowing machines and other farm machinery have recently been made at the station.

WASHINGTON STATION.—The station farm comprises 218 acres, 150 of which are under cultivation. It is estimated that the yield this year will be at least 50 bushels

per acre. A brick building is in process of erection, and it is expected that the station will be equipped for its work during the coming winter. George Lilley is director of the station.

WYOMING COLLEGE.—The name of the president of the college is A. A. Johnson, instead of T. A. Johnson, as printed in Circular No. 20 of this Office.

QUEENSLAND.—Bulletin No. 8 of the Department of Agriculture at Brisbane, issued February, 1891, is edited by E. M. Shelton, and is made up of abstracts of bulletins of the New Hampshire, Michigan, Tennessee, Missouri, Massachusetts Hatch, Alabama College, and Louisiana Stations.

RUSSIA.—A law enacted May 11, 1891, regarding the manufacture and sale of oleomargarine and artificial butter in the Empire is summarized in the *Milch Zeitung*, No. 49, 1891, as follows:

(1) The law understands by the term "margarine" the material prepared from fresh beef fat, after the separation of the stearine, according to the method of Mège Mouriés; and by "artificial butter," the material prepared from 100 parts by weight of margarine and 100 parts by weight of milk or 10 parts of cream.

(2) The manufacture of margarine and artificial butter is restricted to establishments fitted up exclusively for this purpose.

(3) Such establishments, as well as slaughterhouses furnishing them with crude materials, will be under the supervision of special officials, to be appointed by the minister of finance. The expense of this supervision is to be contributed by the manufacturers.

(4) It is forbidden (*a*) to color margarine or artificial butter the color of cows' butter; (*b*) to mix margarine or other fats with cows' butter for the purpose of selling, to bring such mixtures into the market or to store in places where cows' butter is kept or sold.

(5) All vessels in which it is exposed for sale must be plainly marked "Margarine" or "Artificial Butter." Tubs or boxes containing these materials must also bear the name of the manufacturer.

(6) All stores or establishments dealing in oleomargarine or artificial butter must display in a prominent place a placard to this effect.

(7) The selling of these materials in stores which are especially for the sale of dairy products is not allowable.

(8) The importation of these materials from other countries is forbidden.

(9) The Minister of Finance and the Minister of the Interior are charged with the execution of the law, and the seeing to it that the manufacture is carried on under proper sanitary conditions.

The penalty for offering adulterated cows' butter for sale, or the storing of such adulterated butter where cows' butter is made or sold, is forfeiture of the material and imprisonment not exceeding one month, or a fine not exceeding 100 rubles ($77). The penalty for disregard of the other clauses of the law as to manufacture and sale, is forfeiture of the material and a fine not exceeding 100 rubles.

STATION AT DARMSTADT, GERMANY.—According to a recent report by Prof. Paul Wagner*, 411 samples of Thomas slag were sent to the station for analysis during 1890. The percentages of phosphoric acid contained in these samples are grouped as follows: In 9 samples 10 to 12 per cent., in 72 samples 12 to 14, in 121 samples 14 to 16, in 110 samples 16 to 18, in 73 samples 18 to 20, in 26 samples over 20. The average percentage was 16.21 per cent. There was also considerable variation in the mechanical condition of the samples, the percentage of fine meal† ranging from 50 to 95; 89 samples contained less and 322 samples more than 75 per cent of fine meal.

* Zeitsch. f. d. landw. Ver. Hessens.

† Experiment Station Record, vol. II, p. 523.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING JULY, 1891.

DIVISION OF STATISTICS:

Report No. 86 (new series), July, 1891.—Report of the Area of Corn, Potatoes, and Tobacco, and the Condition of Growing Crops; Freight Rates of Transportation Companies.

Fiber Investigation, Report No. 3.—A Report on Sisal Hemp Culture.

DIVISION OF FORESTRY:

Bulletin No. 5.—What is Forestry?

DIVISION OF BOTANY:

Contributions from the U. S. National Herbarium, vol. I, No. 4, June 30, 1891.—List of Plants Collected by Dr. Edward Palmer in 1890 in Western Mexico and Arizona.

OFFICE OF IRRIGATION INQUIRY:

Report of Special Agent in Charge of the Artesian and Underflow Investigations and of the Irrigation Inquiry for 1890.

Progress Report on Irrigation in the United States, part I.

Progress Report on Irrigation in the United States, part II.—Artesian and Underflow Investigations between the Ninety-Seventh Degree of West Longitude and the Foothills of the Rocky Mountains.

DIVISION OF GARDENS AND GROUNDS:

Papers on Horticultural and Kindred Subjects.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Bulletin No. 2, part II.—Digest of Annual Reports of the Agricultural Experiment Stations in the United Stations for 1888.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING JULY, 1891.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF CALIFORNIA:

Bulletin No. 93, June 25, 1891.—Investigation of California Oranges and Lemons.

THE DELAWARE COLLEGE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 13, July, 1891.—Leaf Blight of the Pear and the Quince.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF ILLINOIS:

Bulletin No. 16, May, 1891.—Experiments in Pig Feeding; Composite Milk Samples Tested for Butter Fat.

IOWA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 13, May, 1891.—Experiment in Feeding for Milk; Treatment of Fungous Diseases; Some Insects Destructive to Grass; Blossoms of the Orchard Fruits—their Relative Hardiness; Some Observations on Contaminated Water Supply for Live Stock.

LOUISIANA AGRICULTURAL EXPERIMENT STATIONS:

Bulletin No. 10 (second series).—Systematic Feeding of Work Stock a Preventive of Disease; Some of the Diseases of Farm Animals.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:

Meteorological Bulletin No. 30, June, 1891.

MISSISSIPPI AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 15, June, 1891.—Feeding; Milk Testing Apparatus.

NEW JERSEY STATE AND COLLEGE AGRICULTURAL EXPERIMENT STATIONS:

Bulletin No. 81, July 1, 1891.—Incomplete Fertilizers and Home Mixtures.

Bulletin No. 82, July 3, 1891.—The Rose Chafer or Rose Bug.

NEW YORK AGRICULTURAL EXPERIMENT STATION:

Ninth Annual Report, 1890.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 28, June, 1891.—Experiments in the Forcing of Tomatoes.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION:

Annual Report of the Meteorological Division, 1890.

WEST VIRGINIA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 14, February, 1891.—Farm and Garden Insects; Notes of the Season.

Bulletin No. 16, April, 1891.—Forest and Shade-Tree Insects—Yellow Locust.

Bulletin No. 17, May, 1891.—Forest and Shade-Tree Insects—Black Spruce.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF WISCONSIN:

Bulletin No. 28, July, 1891.—The Construction of Silos.

DOMINION OF CANADA.

BUREAU OF INDUSTRIES, TORONTO, ONTARIO.

Annual Report, parts I, II, III, IV, and V, 1889.

DEPARTMENT OF AGRICULTURE:

Bulletin No. 12, June, 1891.—Indian Corn or Maize as a Fodder Plant; Report on the Chemical Composition of Certain Varieties of Indian Corn.

Bulletin No. 13, June 2, 1891.—Report of Progress of the Work of the Experimental Farms.

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A. W. HARRIS, DIRECTOR

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EDITORIAL NOTES.

Renewed interest in the investigations conducted at Rothamsted, England, under the direction of Sir John Bennet Lawes, has been awakened by the lectures of Mr. Robert Warington delivered before the Association of American Agricultural Colleges and Experiment Stations at its recent meeting in Washington, D. C. This course of lectures is the first of a series to be given once in two years in this country, in accordance with the provisions of what is known as the Lawes Agricultural Trust. The lectures of Mr. Warington will be published by the Department of Agriculture as a bulletin of this Office, and a summary of them will be given in the Experiment Station Record. The following general statements explanatory of the work carried on at Rothamsted have been taken for the most part from a pamphlet descriptive of the origin, plan, and results of the field and other experiments at that place, issued in June, 1891. As early as 1834 Mr. (now Sir) John Bennet Lawes began experiments in agriculture at his hereditary estate at Rothamsted, Hertfordshire, 25 miles from London. At first the experiments were with different fertilizers applied to plants in pots. Afterwards similar investigations were made in the field. Such striking results were obtained, especially in those experiments where the neutral phosphate of lime in bones, bone ash, and apatite, dissolved in sulphuric acid, were applied to root crops, that the scale on which the trials were made was enlarged from time to time. In 1843 the field experiments were so systematized that it is fairly claimed that "the foundation of the Rothamsted Experimental Station may be said to date from that time." For a number of years laboratory work was carried on in a barn, but the results obtained at Rothamsted attracted so much attention that a new laboratory was built by public subscription of agriculturists, and presented to Sir John in 1855. In the autumn of 1888 another building was erected, comprising two large rooms for the storing of specimens and for some processes of preparation, and also a drying room. The station now has a "collection of more than 40,000

bottles of samples of experimentally grown vegetable produce, of animal products, of ashes, or of soils, besides some thousands of samples not in bottles." Dr. J. H. Gilbert has been associated with Sir John since June, 1843, and has had charge of the laboratory. The number of assistants and other helpers has been increased from time to time. During the past twenty-five years the working staff has consisted of from one to three chemists and two or three general assistants employed in routine chemical work and in carrying out the details of field and feeding experiments. A botanical assistant has also occasionally been employed. Besides these workers, there have been from two to four computers and record keepers, a laboratory man, and other helpers. Chemical work has also been done for the station in London and elsewhere. In this way Mr. R. Richter, formerly connected with the Rothamsted laboratory, has made numerous ash analyses of animal and vegetable products at Charlottenburg (Berlin), Germany, where he is at present located.

"The general scope and plan of the field experiments has been to grow some of the most important crops of rotation, each separately, year after year for many years in succession, on the same land, without manure, with farmyard manure, and with a great variety of chemical manures, the same kind of manure being, as a rule, applied year after year on the same plat. Experiments on an actual course of rotation, without manure, and with different manures, have also been made."

Experiments with different fertilizers on wheat have been made for 48 years on 11 acres of land, on barley for 40 years on 4¼ acres, on oats 10 years on three quarters of an acre, on beans for from 27 to 32 years on 2¼ acres, on clover 29 years on 3 acres, on turnips 28 years on 8 acres, on sugar beets 5 years on 8 acres, on mangel-wurzels 16 years on 18 acres, on potatoes 6 years on 2 acres, on permanent grass 36 years on 7 acres, and on crops in rotation 44 years on 3 acres. Varieties of wheat have been tested during 15 years on from 4 to 8 acres. Wheat has been grown in alternation with fallow for 40 years on 1 acre, and in alternation with beans for 28 years on 1 acre. Experiments with various leguminous plants have also been made during 14 years on 3 acres. Comparative experiments with different manures have been conducted on other kinds of soils in other localities.

"Samples of all the experimental crops are taken and brought to the laboratory. Weighed portions of each are partially dried at 100° C., the dry matter determined, and then burnt to ash on platinum sheets in cast-iron muffles. The quantities of ash are determined and recorded, and the ashes themselves are preserved for reference or analysis.

"In a large proportion of the samples the nitrogen is determined, and in some the amount existing as albuminoids, amides, and nitric acid.

In selected cases, illustrating the influence of season, manures, exhaustion, etc., complete ash analyses have been made, numbering in all more than 700. Also in selected cases, illustrating the influence of season and manuring, quantities of the experimentally grown wheat grain have been sent to the mill, and the proportion and composition of the different mill products determined. In the sugar beet, mangel-wurzel, and potatoes the sugar in the juice has in many cases been determined by polariscope, and frequently by copper also.

"In the case of the experiments on the mixed herbage of permanent grass land, besides the samples taken for the determination of the chemical composition (dry matter, ash, nitrogen, woody fiber, fatty matter, and composition of ash), carefully averaged samples have frequently been taken for the determination of the botanical composition, In this way, on four occasions, at intervals of five years, viz, in 1862, 1867. 1872, and 1877, a sample of the produce of each plat was taken and submitted to careful botanical separation, and the percentage by weight of each species in the mixed herbage determined. Partial separations, in the case of samples from selected plats (frequently of both first and second crops), have also been made in many other years."

More than 1,600 samples have been taken from the soils of the experiment plats at depths of from 9 to more than 100 inches. These have been submitted to a partial mechanical separation, and in a large number of cases the loss on drying at different temperatures and on ignition has been determined.

"In most the nitrogen determinable by burning with soda lime has been estimated. In many the carbon, and in many the nitrogen as nitric acid, and the chlorine have been determined. Some experiments have also been made on the comparative absorptive capacity (for water and ammonia) of different soils and subsoils. The systematic investigation of the amount and the condition of the nitrogen, and of some of the more important mineral constituents of the soils of the different plats, and from different depths, is in progress or contemplated."

Almost from the commencement of the experimental work at Rothamsted the rainfall has been measured by means of gauges.

"From time to time the nitrogen, as ammonia and as nitric acid, has been determined in the rain waters. The chlorine and the sulphuric acid have also been determined in a considerable series of samples."

The quantity and composition of the water percolating through soil at depths of 20, 40, and 60 inches, has been determined with the aid of three "drain gauges" constructed for the purpose. The drainage waters from the differently manured plats of the permanent experimental wheat fields are frequently analyzed.

"Professor Frankland has determined the nitrogen, as ammonia, as nitric acid, and as organic nitrogen, and also some other constituents, in many samples both of the rain and of the various drainage waters

collected at Rothamsted. The late Dr. Voelcker also determined the combined nitrogen, and likewise the incombustible constituents, in 65 samples of the drainage waters; and Dr. W. J. Russell has determined the sulphuric acid in some of the monthly mixed samples of rain water.

"The nitrogen existing as nitric acid, sometimes that in other forms, and also some other constituents, are and for some time past have been determined periodically in the Rothamsted laboratory, in both the rain and the various drainage waters."

For several years experiments were made to determine the amount of water given off by graminaceous, leguminous, and other plants during their growth. Similar experiments have also been made with various evergreen and deciduous trees.

"Having regard to the difference in the character and amount of the constituents assimilated by plants of different botanical relationships under equal external conditions, or by the same description of plants under varying conditions, observations have been made on the character and range of the roots of different plants, and on their relative development of stem, leaf, etc. In the case of various crops, but more especially with wheat and beans, samples have been taken at different stages of growth and the composition determined in more or less detail, sometimes of the entire plant and sometimes of the separated parts. In a few cases the amounts of dry matter, ash, nitrogen, etc., in the above ground growth of a given area, at different stages of development, have been determined. The amounts of stubble of different crops have also occasionally been estimated."

Among the most widely known of the experiments at Rothamsted are those with reference to the assimilation of free nitrogen by plants, commenced in 1857 and conducted for several years. The conclusion arrived at, that our agricultural plants do not themselves directly assimilate the free nitrogen of the air by their leaves, has been generally accepted. Since the experiments of Atwater have shown that the free nitrogen of the air is assimilated by leguminous plants, and those of Hellriegel and others have shown that this assimilation takes place through the aid of microörganisms, either within the soil or in symbiosis with plants of a higher order, in which process the root tubercles of these plants play an important part, experiments at Rothamsted have confirmed the results obtained elsewhere.

" Experiments with the animals of the farm were commenced early in 1847, and have been continued at intervals up to the present time.

"The following points have been investigated:

"(1) The amount of food and of its several constituents consumed in relation to a given live weight of animal within a given time.

"(2) The amount of food and of its several constituents consumed to produce a given amount of increase in live weight.

"(3) The proportion and relative development of the different organs or parts of different animals.

"(4) The proximate and ultimate composition of the animals in different conditions as to age and fatness, and the probable composition of their increase in live weight during the fattening process.

"(5) The composition of the solid and liquid excreta (the manure) in relation to that of the food consumed.

"(6) The loss or expenditure of constituents by respiration and the cutaneous exhalations, that is, in the mere sustenance of the living meat-and-manure-making machine. [This has not been determined with the respiration apparatus, but only by calculations based on the amounts of dry matter, ash, and nitrogen in the food, feces, and urine.]

"(7) The yield of milk in relation to the food consumed to produce it, and the influence of different descriptions of food on the quantity and on the composition of the milk. * * *

"Independently of the points of inquiry above enumerated, the results have supplied data for the consideration of the following questions:

"(1) The characteristic demands of the animal body (for nitrogeneous or nonnitrogeneous constituents of food) in the exercise of muscular power.

"(2) The sources in the food of the fat produced in the animal body.

"(3) The comparative characters of animal and vegetable food in human dietaries."

In these investigations several hundred animals, including cattle, sheep, and pigs, have been used.

An extensive investigation regarding to the use of the sewage of towns as fertilizers for different crops, especially for grass, was carried on in coöperation with the late Professor Way. The amount, composition, and nutritive value of crops grown with this fertilizer were studied.

"The chemistry of the malting process, the loss of food constituents during its progress, and the comparative feeding value of barley and malt have been investigated."

Experiments commenced in 1884 are still in progress with reference to the changes which crops undergo in the process of ensiling, and the relative value of different kinds of silage as feeding stuffs.

The records and results of the investigations by the Rothamsted Station have been published in the *Journal of the Royal Agricultural Society of England*, *Journal of the Chemical Society*, *Philosophical Transactions of the Royal Society*, *Journal of the Society of Arts*, *Reports of the British Association for the Advancement of Science*, and elsewhere. The list of articles published 1847–91, inclusive, embraces 115 titles. Sir John Lawes has recently presented complete sets of these publications to a considerable number of the agricultural colleges and experiment stations in this country.

The Rothamsted Station has been maintained entirely from the private resources of its founder, who, for the perpetuation of the work, has placed in the hands of trustees a fund of £100,000, the laboratory, and certain tracts of land. In accordance with the provisions of the deed of trust the station is now carried on under a committee of management, of which Sir John is a member.

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

California Station, Bulletin No. 93, June 25, 1891 (pp. 6).

ANALYSES OF CALIFORNIA ORANGES AND LEMONS, G. E. COLBY, PH. B., AND H. L. DYER.—In a brief introduction to the bulletin, Director Hilgard states that owing to an increase in the working force of the station, investigations of California fruits with regard to their comparative nutritive value and fertilizing ingredients will be carried on more extensively than formerly. This article comprises brief descriptive notes and tabulated proximate and ash analyses for 23 samples of oranges and 4 of lemons. The varieties of oranges included in the samples analyzed were Navel, Mediterranean Sweet, St. Michaels, Malta Blood, Valencia, Tangerine, and a seedling; the lemons were Eureka and Arroyo Grande Pride. The average results of the analyses were as follows:

Averages of proximate analyses of oranges and lemons.

	Physical analysis.					Juice.					
	Average weight.	Rind.	Pulpless juice.	Seeds.	Juice average.	Solid contents by spindle.	Total sugars by copper (inversion).	Cane sugar (polariscope).	Acid (citric).	Nitrogen in fresh fruit.	Albuminoids in fresh fruit equivalent to nitrogen.
	Grams.	*P. ct.*	*P. ct.*	*P. ct.*	*c. c.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Oranges:											
Navel	300	28.4	27.7	......	107	12.80	9.92	4.80	1.02	0.211	1.31
Mediterranean Sweet	202	27	24	0.8	86	2.60	9.70	4.35	1.38	0.154	0.96
St. Michaels	138	19.2	25.9	1.6	65.4	12.10	8.71	3.48	1.35	0.228	1.43
Malta Blood	177	31	24	......	71	13.55	10.30	5.85	1.61	0.168	1.05
Lemons:											
Eureka	104	32	24.5	0.12	38	11.90	2.08	0.57	7.66	0.151	0.94

Averages of ash analyses of oranges and lemons.

	Oranges.	Lemons.
	Per cent.	*Per cent.*
Pure ash in fresh fruit	0.432	0.526
Composition of pure ash:		
Potash (K_2O)	48.94	48.26
Soda (Na_2O)	2.50	1.76
Lime (CaO)	22.71	29.87
Magnesia (MgO)	5.34	4.40
Oxide of iron (Fe_2O_3), and alumina (Al_2O_3)	0.97	0.43
Oxide manganese ($Mn\ O_4$)	0.37	0.28
Phosphoric acid (P_2O_5)	12.37	11.09
Sulphuric acid (SO_3)	5.25	2.84
Silica (SiO_2)	0.65	0.66
Chlorine (Cl)	0.92	0.39
Total	99.98	98.98

The results of the analyses are discussed as follows:

Oranges, proportion of rind to flesh.—Considering the matter first from the standpoint of the consumer, it seems that although the Navel is the largest of oranges, it has, contrary to the popular impression, no advantage with respect to the proportion of skin to flesh over either the Mediterranean Sweet or St. Michaels. The average Navel can fairly be considered as containing nearly 72 per cent of flesh, while the average Mediterranean Sweet shows 73 per cent, and the St. Michaels 81 per cent.

Juiciness or proportion of juice to flesh.—A comparison of the figures in the table shows that of the named varieties examined the Navel is the driest, while the St. Michaels has the largest proportion of juice, the Mediterranean Sweet being next and the Malta Blood third.

These facts will be better understood by reference to the little table below, which gives the percentage ratios.

Variety.	Proportion of rind to flesh.		Proportion of pulp to juice in flesh.	
	Rind.	Flesh.	Pulp.	Juice.
Navel	28.4	71.6	39	61
Mediterranean Sweet	27	73	33	67
St. Michaels	19	81	31	69
Malta Blood	31	69	36	64

Evidently the hard and solid, although thin rind of the Navel weighs heavier in the balance than the more "corky" one of the Mediterranean Sweet, and doubtless outweighs also that of many seedlings. * * *

Sugar content of the juice.—The table shows the maximum of sugar [11.2 per cent] in the hill-grown Navel from Pomona (No. 6), but this is approached very closely [11.1 per cent] by Navel No. 8, the Mediterranean Sweet No. 9 [, 10.09 per cent], the Malta Bloods from Pomona Nos. 18 [11.1 per cent] and 19 [11.02 per cent], and the Tangerine from San Gabriel No. 22 [11.03 per cent]. It is notable that the latter shows at the same time the highest proportion of cane sugar [7.41 per cent] to be found in the whole series, the Pomona Navels and Malta Bloods standing next. To what extent the proportion of cane sugar determines the sweetness to the taste, is a matter not yet fully understood, the proportion between the other two sugars (grape and fruit), not yet determined, being an essential factor in the case.

The average sugar content of the fully ripe Navels (gathered in April and May) from all localities is 10.8 per cent. Against this we find Mediterranean Sweets from Riverside and Pomona, Nos. 11 and 12 (gathered in May), to average 9.7 per cent only; while the seedling from Smartsville, gathered in January, shows a little over

10 per cent, thus indicating a very early maturity. The Valencia orange from Pomona (No. 21) shows a decidedly lower sugar percentage [9.2 per cent], as does the contemporaneous Malta Blood from Riverside [8.8 per cent]. The St. Michaels shows the lowest average of all the oranges (8.71 per cent), although the roundish sample from Pomona falls only a little below 10 per cent.

Comparing these data with those of previous years, heretofore published, we find that the sugar percentage of the Navel appears to have risen from 9.89 per cent to 10.80 per cent. For the Mediterranean Sweet the figure remains practically identical. For the St. Michaels it is higher than we have found it this season.

Acid in the juice.—In respect to acid, we note at once the maximum in the Malta Blood of over 2 per cent, with an average of 1.6 per cent in the three samples examined. The next highest figures occur in the early samples of Mediterranean Sweet from Smartsville, a maximum of 1.68 per cent; but the average of the May samples from Riverside and Pomona is 1.23 per cent. The St. Michaels of Marysville, January 22, shows the next highest maximum with 1.46 per cent, but in the later samples of April and May we find in the Riverside sample (No. 14) a minimum of 0.84 per cent, with an average of 1.07 for the four later samples examined. In contrast to the Malta Blood, therefore the St. Michaels counts among the varieties of low acid, combined, however, with rather a low sugar percentage, as stated above.

The Valencia rates in nearly the same respect with the St. Michaels, while the Tangerine shows the low figure of 0.87 per cent of acid, with, at the same time, a very high sugar percentage. A former analysis showed for its close relative, the Mandarin, a lower minimum of acid (0.36 per cent), and the highest sugar percentage on record—13.84 per cent.

The Navel justifies the statement, made in a former report, of the low acid percentage even in samples gathered as early as January and still more in those of later date from Riverside and Pomona. The minimum of all (0.77 per cent) is shown by the Pomona fruit (No. 6), with, at the same time, the highest sugar percentage (11.20) of the series. In the aggregate the average acid percentage of the Navel is the lowest of all, with the highest average of sugar (9.92 per cent), outside of the Malta Blood. These data, together with its firm flesh, thin and smooth rind, and excellent keeping qualities, sufficiently explain the great preference given it in our markets.

Comparing the results obtained in 1891 with those in previous publications of this Department (1879–87) we note first an apparent increase in the average weight of the several varieties. We also find that while the percentages of rind show very nearly the same average as in 1891, there is a marked discrepancy in respect to juiciness, the pressed pulp averaging about 25 per cent less in earlier specimens. How far these differences may be due to influences of season or accident in sampling is difficult to decide with the data before us; the more so as the acid and sugar percentages show very nearly the same absolute as well as relative figures. Increased age of the bearing trees may possibly account for some of these differences. * * *

Nutritive values—nitrogen content.—The flesh-forming ingredients (albuminoids) of any article of food being of great importance as regards its proper uses, it is of special interest to compare in this respect the orange with other fruits, and the different varieties of oranges with each other. According to the latest European data, oranges stand first in the amount of albuminoids (1.73 per cent), prunes second (0.78 per cent), peaches (and probably apricots) third, bananas and grapes fourth, while apples and pears stand nearly the lowest on the list (0.375 per cent). Our determinations of the same substances in California oranges as a whole (rind included) show materially smaller figures, averaging 1.20 per cent; and as it is known that the rind is very poor in these substances, we are forced to conclude that the California fruit is less nourishing than that of Sicilian production. Much lower percentages, however, are quoted for oranges from other sources. Here again the differences observed may be largely due to the age of the trees bearing the fruit, which in California is usually the minimum.

Of the entire series, the Riverside Navels show the highest content of albuminoids (1.54 per cent), while the average of the Pomona sample is 1.18 per cent only. Next highest to the Riverside Navels come the St. Michaels from Marysville, Riverside, and Pomona, with an average of 1.4 per cent; nearly the same is shown by the Riverside Malta Bloods. The average of the Mediterranean Sweets falls below 1 per cent, that from Pomona falling to 0.91 per cent. The Malta Blood and Niles seedling show the minima of 0.69 per cent and 0.75 per cent. The Valencia and Tangerine, with the Eureka lemon, seem to range about 1 per cent.

Ash composition and nitrogen content.—As will be seen by reference to Bulletin No. 88 of the station [see Experiment Station Record, vol. II, p. 272], the orange stands second (grapes being first) among orchard fruits in the quantity of mineral matter withdrawn from the soil. Heretofore we have been obliged to base all conclusions bearing upon the ash and nitrogen of these fruits on European data; we are now enabled to present for oranges and lemons the outcome of California growth. The following summary (based on averages from the large table) shows in tabular form the amounts, in pounds, of the soil ingredients extracted by an orange or lemon crop that will have to be replaced by fertilization.

	Total ash.	Potash.	Phosphoric acid.	Nitrogen.
Oranges:				
European (seedless)—	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Crop of 1,000 pounds	6.07	2.78	0.67	2.69
Crop of 20,000 pounds	121.40	55.60	13.40	53.80
California—				
Crop of 1,000 pounds	4.32	2.11	0.53	1.83
Crop of 20,000 pounds	80.40	40.14	10.60	36.60
Lemons:				
Crop of 1,000 pounds	5.57	2.69	0.61	1.51
Crop of 20,000 pounds	111.40	53.80	12.20	30.20

It thus appears that so far as oranges are concerned the California fruit draws materially less upon all the soil ingredients that have to be replaced by fertilization than the European; while as regards the lemon, it approaches closely to the European standard for the orange, save in the much smaller draft upon nitrogen. * * *

Lemons.—The incompleteness of the data concerning lemons renders it inadvisable to enter upon any extended discussion, the more so as no extended data from the Old World are available for comparison. It will be noted that the most important ingredient of this fruit, viz, the acid percentage, considerably exceeds, for the Eureka lemon [7.66 per cent] at least, the commonly assumed average, and in the case of No. 26, from San Gabriel [7.88 per cent], the acid percentage is extraordinary. This point alone should insure to California-grown lemons a high position in commerce.

The relatively large percentage of sugar shown by the analyses is a feature which will further commend them to the consumer's taste as against the percentages usually reported. It will be observed, however, that very great differences exist in the proportion of rind to flesh and extractable juice. In this respect the lemons of Pomona [2.22 per cent] and Ontario [2.37 per cent] stand at the head of the list as far as it goes.

In ash composition there is no material difference between the oranges and lemons examined. With a more extended series the variations in both would doubtless be shown to run parallel.

Colorado Station, Third Annual Report, 1890 (pp. 227).

REPORT OF DIRECTOR, C. L. INGERSOLL, M. S. (pp. 3–9).—Brief statements regarding the work of the station in 1890.

PLAN OF EXPERIMENTS FOR 1890 (pp. 10–13).—An outline of the work planned for the sections of agriculture, chemistry, meteorology

and irrigation engineering, and botany and horticulture. Previous reports of work in similar lines may be found in the Annual Reports of the station for 1888 and 1889 (see Experiment Station Bulletin No. 2, part I, p. 27, and Experiment Station Record, vol. II, p. 392).

REPORT OF AGRICULTURAL SECTION, R. H. McDOWELL, B. S. (pp. 14–24).—Tabulated data and brief notes are given for 12 varieties of oats, 12 of barley, 21 of wheat, 17 of sorghum, 3 of millet, and 32 of foreign wheat. There are also notes on tests for soil variations with corn and wheat and on experiments with millo maize, vetches, lupines, Russian sunflowers, lentils, Aztec coffee, cowpeas, flax, grasses, clovers, and other forage plants.

REPORT OF CHEMICAL SECTION, D. O'BRINE, D. SC. (pp. 25–28).—The results of a large share of the work of this section were published in Bulletins Nos. 10, 11, and 12, of the station (see Experiment Station Record, vol. II, pp. 11, 99, 319). Two hundred and seventy-nine analyses were made during the year, including sugar beets, irrigation waters, grasses, loco weed, larkspur, etc. Forty-two samples of rain and snow were analyzed with reference to nitrates and ammonia.

REPORT OF SECTION OF BOTANY AND HORTICULTURE, C. S. CRANDALL, M. S. (pp. 29–54).—This includes tabulated data and brief notes for 26 varieties of strawberries, 6 of blackberries, 6 of raspberries, 87 of grapes, 40 of potatoes, 46 of tomatoes (28 of which have been previously reported), 43 of peas, 9 of peppers, 6 of cucumbers, 8 of cabbages, 3 of onions, and 6 of sugar beets. One hundred and seventy species of weeds have been observed in the locality of the station, of which 42 "are very abundant and very persistent in cultivated ground."

REPORT ON APIARY, C. M. BROSE (pp. 55, 56).—A brief account is given of an experiment in growing the Chapman honey plant (*Echinops sphærocephalus*). The station owns 31 colonies of bees.

REPORT OF SECTION OF METEOROLOGY AND IRRIGATION ENGINEERING, L. G. CARPENTER, M. S. (pp. 57–155).—This contains articles on water supply, irrigation statistics of 1890, irrigation literature, meteorological observations, and observations of soil temperatures.

Water supply.—The water supply of 1890, while in some respects better than in previous years, was still insufficient for the purpose of irrigation. A table is given showing the maximum flow of nine streams in the State in 1888 and 1890. The discharge of the Cache a la Poudre River is tabulated for each day from November 1, 1889, to November 8, 1890, inclusive. The total flow of this stream for the 12 months is calculated to have been 248,193 acre-feet.

This is enough to cover 248,193 acres 1 foot deep; or this amount would be enough to cover 386 square miles 1 foot deep. As the area of the watershed of the Poudre above the measuring weir is 1,008 square miles, this is equal to a run-off of a sheet of water 4⅝ inches deep over the whole area. * * * Taking the basin as a whole, the average precipitation above the point where the gauging station is placed may be fairly estimated at 14 inches. This being true, the total run-off equals one third of the precipitation.

Comparing the flow of the river during the irrigation season with the area cultivated, we get an approximation to the average duty of water as it has been in this valley during this year. It can not, however, be said to be a just estimate, as the water was confessedly not sufficient. A just measure of the duty of water should be based on the amount that is sufficient to furnish the crop the needed amount of moisture. Much of the land this year did not receive all that was needed, and the late crops were successful only because of the copious rains of August. We may take the season as from April to September, as the water between the first days of these months was nearly all used for irrigation, much of that of April being stored and used subsequently. In these 5 months the total flow was 211,811 acre-feet, or, as the area watered from the waters of the river is very nearly 135,000 acres, it was equivalent to a depth of 18.6 inches over the irrigated area. Hence, during these 5 months each cubic foot per second was called upon to furnish water for 196 acres. This is greater than the duty when there is sufficient water, for, as stated above, much land suffered from a scarcity.

In addition to the watei from the river, there was a rainfall which amounted to 9.64 inches at the college—near the exit of the river from the foothills—and of about 8 inches at Greeley, at the lower end of the valley, or an average of over 8 inches from the rain. The total depth of water from both sources has then been nearly 27 inches.

The duty of water found for the whole district by the method above used, gives a result that seems excessive to all who are intimately acquainted with this valley. The method is defective inasmuch as it does not take into account the areas which did not have sufficient water. To get the duty of water which is practically useful, we should know the amount that would be used if the irrigator had all that he needed and at the times when he needed it, and a supply scant enough to insure that none goes to waste.

Tabulated data are given for the duty of water under the Cache a la Poudre Canal No. 2 (one of the oldest of the large canals on the river) from May 27 to September 10, inclusive.

For the last four days in May the amount flowing into the canal equals the flow of 1,791 cubic feet per second for one day; in June, 10,425; in July, 6,213; in August, 3,186, and for the portion of September here given, 662; or for the whole period, 22,277. As the flow of one cubic foot per second is sufficient to cover one acre 2 feet deep, very nearly, or 2 acre-feet in one day, the amount of water used by this canal from May 27 to September 10 was 44,500 acre-feet. As it is known with some degree of accuracy that the area which depends on water from this ditch is between 24,000 and 25,000 acres, this flow would therefore be sufficient to cover the whole area with water over 21 inches deep. If the flow during May and April be added, this depth would be increased. The rainfall also increases the depth of the water that has been used on the land. In the interval covered by these measures, the average duty, excluding rain, is nearly 120 acres per second-foot, while for the valley as a whole it is 196 acres. During the month of June, water was used at the rate of 72 acres per second-foot, assuming that all the land was irrigated. As a matter of fact, the irrigation of this month was confined almost entirely to the crops of cereals and alfalfa, which occupied about two thirds of the 25,000 acres.

The above facts suggest that if one wishes to use the duty of water to determine the amount of water he will need to water a given area, that the average duty is very misleading; and that during the period when water is wanted in greatest quantities, the duty ordinarily taken as the basis of water rights in Colorado, viz, 55 acres per second-foot, is the safer guide.

Irrigation statistics of 1890.—Tabulated estimates are given of the area under ditch in Colorado, the area irrigated, mileage of canals, and cost of irrigation works during 1889. Canal construction was most

active in the Arkansas Valley, where the area brought under ditch aggregates some 700,000 acres. It is estimated that the total area under ditch in Colorado at the end of 1890 was 6,337 square miles, or 4,068,409 acres; the area irrigated, 1,635,000 acres. The mileage of canals was 6,317, not including numerous short ditches in the mountain regions. The cost of irrigation works in Colorado is roughly estimated at $10,980,000.

Irrigation literature.—A list of 71 works bearing on the subject of irrigation, with brief comments on the character and scope of each.

Meteorological observations.—Tabulated data are given of the monthly precipitation at the station for 14 years (1872–90), and for twenty localities in the State for 1890; daily observations of the dew-point and relative humidity for each month of 1890; the monthly evaporation at the station and at the San Luis and Rocky Ford substations; monthly and daily observations of the sunshine in hours and minutes for 1890 at the three stations; daily actinometer readings from April 1 to November 12, 1890, inclusive; daily thermometer readings and range of temperature for each month of 1890; daily terrestrial radiation; thermometer readings for each month of 1890; and the means of two daily readings of the barometer for each month of 1890.

Annual summary of meteorological observations for 1890.

Stations.	Mean pressure.	Air temperature (degrees F.).					
		Highest.	Lowest.	Mean.	Mean daily range.	Greatest daily range.	No. of days minimum temperature below 32° F.
	Inches.						
Fort Collins	25.010	95.3	—20	49.08	31.33	48.09	168
Del Norte	22.644	89	—16	44.80	32.12	....	217
Rocky Ford	....	104	—10	50.7	....	....	147

Stations.	Humidity.			Wind.		Precipitation.			Sunshine.	
	Mean dew-point.	Mean relative humidity.	No. of days on which dew was observed.	Prevailing direction.	Maximum velocity per hour.	Total precipitation (rain and melted snow).	Total snow fall.	No. of days on which 0.01 inch of rain or melted snow fell.	Per cent.	Total hours.
					Miles.	*Inches.*	*Inches.*			
Fort Collins	40.19	62.48	44	W and SW.	70	11.435	17.8	56	65.1	2,798
Del Norte	32.12	73.37	....	W.	....	8.77	24.75	47	....	....
Rocky Ford	42.73	71.9	....	W.	....	6.93	14.5	27	71.4	....

Soil temperatures.—A tabular record of the weekly means of soil temperatures at depths of from 3 to 72 inches for three sets of soil thermometers placed in soils varying in elevation and moisture.

REPORT OF GRASS STATION, C. S. CRANDALL, M. S. (pp. 156–183).—This is a first year's report of experiments, conducted under the direction of the Division of Botany of the U. S. Department of Agriculture,

in testing different species of grasses and forage plants grown without irrigation. Notes and tabulated data are given for a number of species of grasses and other forage plants sown on plats of different sizes. A list of 41 species of weeds which made their appearance on the grass plats is also given, and a list of grasses, the seeds of which were collected in Colorado from August 29 to September 12, 1890. Of the 99 named species sown at the station in the spring of 1890, 29 species of grasses and 8 of forage plants germinated.

During the weeks following germination, these exhibited all degrees of endurance. Some made scarcely any growth and died after a short struggle; others lived through till late in the summer. Four of the grasses and three of the forage plants have carried a portion of the plants produced through the whole season and are still alive at this writing, November 22. The grasses are *Lolium perenne, Holcus lanatus, Agropyrum tenerum,* and *Festuca elatior*.

The fact that these grasses, sown alone on fresh-broken prairie, have had sufficient power of endurance to retain life in even a portion of the plants produced through a hot and unusually dry summer, is certainly enough to warrant their further trial. Of course it remains to be seen whether the plants now alive will live through the winter. If they do, the strong roots they have will enable them to start early and grow to maturity. The forage plants now alive and giving promise of growth next season are the kidney vetch (*Anthyllis vulneraria*), burnet (*Poterium Sanguisorba*), and *Galega officinalis*.

REPORT OF SAN LUIS VALLEY SUBSTATION, H. H. GRIFFIN, B. S. (pp. 184–201).—Brief notes are given for experiments with wheat, barley, oats, rye, buckwheat, corn, field peas, millet, clover, alfalfa, English rye grass, and sainfoin. Notes, in some cases tabular, are also given for 23 varieties of peas, 12 of cabbages, 2 of cauliflowers, 4 of beets, 5 of sugar beets, 4 of carrots, 8 of onions, 6 of cucumbers, 8 of muskmelons, 7 of watermelons, 21 of beans, 9 of tomatoes, 4 of pumpkins, 12 of squashes, 81 of potatoes, 10 of sweet corn, 1 of sunflowers, 15 of apples, 4 of pears, 2 of plums, 2 of cherries, 16 of strawberries, 3 of blackberries, 6 of raspberries, 2 of gooseberries, 2 of currants, and 3 of grapes. Ten species of forest trees were planted in the spring of 1890. A summary of meteorological observations is also given.

REPORT OF ARKANSAS VALLEY SUBSTATION, F. L. WATROUS (pp. 202–218).—Brief notes are given on experiments with wheat, oats, peanuts, watermelons, muskmelons, beans, potatoes, sweet potatoes, corn, tomatoes, buckwheat, sugar beets, barley, rye, pumpkins, squashes, sweet corn, sorghum, millo maize, peas, cucumbers, cabbages, cauliflowers, eggplants, and celery. There are also brief notes on orchards of apples and pears, the vineyard, and the strawberry bed.

REPORT OF SPECIAL EXAMINING COMMITTEE, D. W. WORKING (pp. 219–222).—This is by a committee of the Colorado State Grange.

REPORT OF TREASURER, F. J. ANNIS, M. S. (pp. 223, 224).—This is for the fiscal year ending June 30, 1890.

Massachusetts Hatch Station, Meteorological Bulletin No. 30, June, 1891 (pp. 4).

This includes a daily and monthly summary of observations for June, 1891, made at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

New Hampshire Station, Bulletin No. 13, May, 1891 (pp. 11).

EFFECT OF FOOD ON THE HARDNESS OF BUTTER, A. H. WOOD, B. S., AND C. L. PARSONS, B. S. (pp. 3–9).—The following experiments were made to study the effect of gluten meal as compared with that of corn meal, cotton-seed meal, or skim milk, and the effect of silage as compared with that of hay on churnability and the character of the butter produced.

In the comparison of gluten meal with corn meal, four lots of two cows each were used. The rations were as follows, lots A and B being fed alternately on the first and second rations in periods of 2 weeks each, and lots C and D on the third and fourth rations:

Pounds per animal daily.

	Silage.	Hay.	Middlings.	Gluten meal.	Corn meal.
First ration	44	6	3	6	....
Second ration	44	6	3	....	6
Third ration	41	6	3	1	5
Fourth ration	41	6	3	5	1

The milk given on the last 2 days in which each ration was fed was taken for testing. The cream was separated by a De Laval hand separator, and was churned after standing about 24 hours (apparently still sweet). Samples of the butter and buttermilk were analyzed, and the relative hardness of the butter was determined by the depth in millimetres, to which a pointed glass rod, weighing 10 grams and falling through a perpendicular glass tube 1 metre in height, penetrated the sample of butter. These determinations of hardness were all made at a temperature of 15.5° C., and it is recommended that the butter be allowed to stand in a cool room for several days previous to the test. The details of the method are described. " Except in very soft butters the differences in triplicate determinations are seldom over 1 millimetre."

The yield of milk on the different rations is not given. From tabulated data regarding the completeness of the separation of the butter fat in churning and the character of the butter, the following summary is taken:

Gluten meal vs. corn meal.

	Fat in buttermilk.		Hardness of butter.	
	Gluten-meal ration.	Corn-meal ration.	Gluten-meal ration.	Corn-meal ration.
	Per cent.	*Per cent.*	*Millimetres.*	*Millimetres.*
Lot A	1.53	0.44	10.0	6.5
Lot B	1.09	0.48	9.3	4.7
Lot C	1.32	0.56	7.6	6.7
Lot D	1.54	0.92	7.3	6.0

These data show that in this experiment, where gluten meal was substituted either in part or wholly for corn meal, a larger percentage of fat remained in the buttermilk and the butter was softer than where the corn-meal rations were fed.

Four cows were used in comparing the effects of hay and silage on the butter, the grain ration (corn meal, middlings, and gluten meal) remaining unchanged; hay was fed alone in one period and was largely replaced by silage in the following period. The experiment was carried out in the same manner as the preceding experiment except that the cream was raised by setting the milk in shallow pans. "Hay apparently produced a harder butter than silage," but with regard to churnability the results were at variance.

In a single trial two cows were fed alternately on rations containing 5 pounds of gluten meal or 5 pounds of cotton-seed meal, the basal ration (silage, hay, corn meal, and middlings) remaining unchanged. The average hardness of the butter (penetration) was 11.4 mm. where gluten meal was fed as compared with 5.5 mm. where cotton-seed meal was fed, indicating that the feeding of cotton seed meal tends to harden the butter, a fact which was also indicated by experiments at the Texas Station (see Texas Station Bulletin No. 11, or Experiment Station Record, vol. II, p. 296).

The comparison of gluten meal (2½ pounds) with skim milk (21 pounds) was made with two cows, the basal ration consisting during the whole trial of 36 pounds of silage, 4½ pounds of hay, and 2½ pounds each of corn meal and middlings. The cows were fed the gluten-meal ration the first period, the skim-milk ration the second period, and returned to the gluten-meal ration the third period. The buttermilk contained 1.35 per cent of fat when the gluten-meal ration was fed as compared with 0.33 per cent when skim milk was fed. The butter was softer with gluten meal than with skim milk.

The principal indications of these experiments were that gluten meal tends to produce a softer butter than corn meal, cotton-seed meal, or skim milk, and, other things being equal, to decrease the churnability of the fat; and that silage produces a somewhat softer butter than hay.

While in general a softer butter was found to melt at a lower temperature than a hard butter, the authors found "no definite relation

between melting point and actual hardness." Except where skim milk was fed, no influence of the food on the volatile fatty acids can be traced. "The iodine absorption of butter from gluten-meal rations is greater than that of butter from cotton-seed or corn-meal rations, and so far as tried the iodine-absorption number follows very closely the hardness of butter."

EFFECT OF FOOD ON QUANTITY OF MILK, G. H. WHITCHER, B. S. (pp. 10, 11).—These observations were made in connection with the above comparison of the effect of gluten meal and corn meal on the butter fat. The nutritive ratio varied in the different rations from 1:5.2 with gluten meal to 1:9 with a like amount of corn meal. The yield of milk by 11 cows on the narrow and wide rations is tabulated. "In almost every case with each of the 11 cows, a change from gluten to corn meal, that is a change from a narrow to a wide nutritive ratio, resulted in a decided falling off in the product, while the reverse change resulted in an equally decided increase." The author believes that for milk production the nutritive ratio should not be much wider than 1 to 6.

New Hampshire Station, Bulletin No. 14, May, 1891 (pp. 8).

SILAGE IN DAIRY FARMING, G. H. WHITCHER, B. S.—This is an argument in favor of the use of silage by dairy farmers in New Hampshire. The advantages claimed for silage are these: (1) More food material can be produced on an acre from corn than from any other of our farm crops; (2) the cost of 100 pounds of dry matter is slightly less in corn than in hay; (3) green food is especially favorable to the production of milk; (4) silage is comparatively convenient and cheap. The author believes that the silo makes the farmer independent of the weather. Late varieties of corn, which produce relatively large amounts of food per acre, can be used for silage, though they would not mature corn in the climate of New Hampshire. The early date at which the silage crop is taken from the land makes it possible to use the same land in grass or winter grain the same year. The cost of harvesting silage corn can be made quite small. An instance is cited of an experiment in which silage was harvested and stored at a cost of 62 cents per ton. For New Hampshire, Sanford corn is recommended as a good variety for silage. Of this, the author thinks 14 to 15 quarts per acre should be used for seed. At the prices for materials and labor in New Hampshire, an independent silo can be built "for $1 per ton of capacity if above 75 tons capacity." If the silo is built in the corner of a barn and farm labor is employed in the construction, the expense can be materially reduced.

New York State Station, Bulletin No. 31 (New Series), May, 1891 (pp. 17).

COMMERCIAL VALUATION OF THE FOOD AND FERTILIZING CONSTITUENTS OF FEEDING MATERIALS, P. COLLIER, PH. D. (pp. 481–497).—An extended popular discussion of the commercial value of the food and fertilizing ingredients of different feeding stuffs as estimated on different bases of valuation, and the relation of these values to the ordinary selling price, together with tabulated average analyses of feeding stuffs, and a statement of the average amounts of food and fertilizing ingredients in dairy products per ton.

New York State Station, Bulletin No. 32 (New Series), June, 1891 (pp. 52).

FERTILIZERS, P. COLLIER, PH. D. (pp. 499–551).—This bulletin is in continuation of the series of popular fertilizer bulletins issued by the station "for the benefit of the farmers of New York State." The present number treats of the different materials used in making commercial fertilizers; the fertilizing materials produced on farms; the fermentation, losses, and care of stable manure; and the influence of kind and age of animals, and of food, on the manure. The bulletin also contains tabulated analyses of 46 samples of commercial fertilizers collected in the State during the fall of 1890; and an extensive compilation of analyses of fertilizing materials and the fertilizing ingredients of farm products, taken from various sources.

New York Cornell Station, Bulletin No. 27, May, 1891 (pp. 14).

THE PRODUCTION AND CARE OF FARM MANURES, I. P. ROBERTS, M. AGR. (pp. 29–42, plate 1, figs. 4).—This work is in continuation of previous investigations as to the loss of fertilizing materials from barnyard manure, published in Bulletin No. 13 of the station (see Experiment Station Record, vol. I, p. 279). The conclusions arrived at in these earlier experiments were as follows:

> The results of one season's trial seem to show that horse manure thrown in a loose pile and subjected to the action of the elements, will lose nearly one half of its valuable fertilizing constituents in the course of 6 months; that mixed horse and cow manure in a compact mass and so placed that all water falling upon it quickly runs through and off, is subjected to a considerable, though not so great a loss; and that no appreciable loss takes place when manure simply dries.

The two experiments here reported were on a larger scale than the previous ones. (1) Two tons of loosely piled horse manure (3,319 pounds excrement and 681 pounds wheat straw) were exposed in a well-drained field from April 25 to September 22, when it was scraped up, weighed, and sampled for analysis. The season was very wet, the rainfall from April to September amounting to 27.66 inches. The total weight and the composition of the horse manure before and after exposure are tabulated. From these analyses the total amounts of the fertilizing ingredients in the fresh and exposed manure are calculated as follows:

Loss of horse manure by exposure.

	Total weight.	Nitrogen.	Phosphoric acid.	Potash.	Commercial value.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	
Fresh horse manure	4,000	19.60	14.80	36.00	$5.60
The same after exposure for 5 months	1,730	7.79	7.79	8.65	2.12

The total loss was considerably more than in the previous year (42 per cent in 1889 and 62 per cent in 1890), but, as in 1889, the greatest loss fell on the potash.

The greater percentage of loss in this experiment is probably due to a greater degree of firefanging caused by the larger proportion of straw used for bedding.

(2) Five tons of cow manure (9,278 pounds excrement, 422 pounds wheat straw, and 300 pounds plaster) were exposed from March 29 to September 22 in a loose pile in the same manner as the horse manure. From the analyses of the manure before and after exposure the total amounts of the various fertilizing ingredients contained in the 5 tons of manure before and after exposure are calculated as follows:

Loss of cow manure by exposure.

	Total weight.	Nitrogen.	Phosphoric acid.	Potash.	Commercial value.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	
Fresh cow manure	10,000	47	32	48	$11.45
The same after exposure	5,125	28	26	44	8.00

It will thus be seen that the total waste in the cow manure was scarcely half what it was in the horse manure. The fermentation of the cow manure was not sufficient to cause any firefanging at all. It is worthy of note that in this experiment the loss of potash was very slight in comparison with that of the phosphoric acid and nitrogen; in all of our other experiments the heaviest loss has been on the potash.

The author summarizes the losses of manure by leaching and fermentation as shown by the results in 1889 and 1890, as follows:

	Original value per ton.	Loss per ton.
Horse manure in loose pile (1889)	$2.45	$1.03
Horse manure in loose pile (1890)	2.80	1.74
Cow manure in loose pile (1890)	2.29	0.69
Mixed manure thoroughly compacted (1889)	2.38	0.22

Amount of manure produced.—The amount and value of the manure voided daily by cows, horses, sheep, and swine are given. While the composition of manure depends very largely upon the kinds of food eaten, an approximate idea of the value of the manure from liberal feeding may be gained from the following summary:

Relative value of the manure per ton, and the amount produced per animal and per thousand pounds live weight.

	Value per ton.	Value per animal per day.	Value per 1,000 pounds live weight per day.	Value per 1,000 pounds live weight per year.
Horses*	$2.79	$0.044	$0.031	$11.47
Horses†		0.073	0.052	19.12
Cows	2.27	0.093	0.082	29.82
Sheep	4.19	0.015	0.106	38.55
Swine	3.18	0.006	0.047	17.11

* Manure voided while at work not included.

† Total excrement calculated on the basis that three fifths was collected in the stable.

A cheap shelter for barnyard manure is described and illustrated.

New York Cornell Station, Bulletin No. 28, June, 1891 (pp. 19).

EXPERIMENTS IN THE FORCING OF TOMATOES, L. H. BAILEY, M. S. (pp. 45–61, figs. 9).—A report on experiments carried on by the author during two winters. Five forcing houses of different kinds are being used.

Our preference is for a house which was designed for tomatoes, having a two thirds span and the ridge 11 feet from the ground. The house is 20 feet wide and built upon a sharp slope. It follows the lay of the land, running nearly east and west. A north and south house would be preferable, probably, because of the more even distribution of light. The framework is unusually light and the glass is 14 by 24 inches.

The experience of the author favors the liberal application of stable manure. "We grow the plants in rich garden loam, to which is added a fourth or fifth of its bulk of well-rotted manure; and when the plants begin to bear, liquid manure is applied every week, or a top-dressing of manure is given." The effect of applying salt, phosphate of soda, nitrate of soda, nitrate of ammonia, or stable manure is graphically shown to illustrate the superior value of the stable manure for tomatoes grown indoors. Seeds sown August 9 yielded the first fruit December 28, and from plants started November 10 the first fruits were picked May 6. The methods employed by the author for training and watering the plants are described. Experiments in the artificial pollination of tomato plants are cited. Where only a little pollen was applied upon one side of the stigma the fruit was small, one-sided, and with seeds only in the half which received the pollen. On the other hand, when pollen was liberally applied to the whole surface of the stigma, the fruit was large and symmetrical and had all its cells developed and seed-bearing. Methods of obtaining a second crop, notes on yields and varieties, on marketing the crop, and on insect and fungus enemies of the tomato are also given. The white scale (*Aleyrodes vaporariorum*) and a small spotted mite are mentioned as serious pests of the tomatoes at the station.

The results of the author's experience in forcing tomatoes are summed up as follows:

(1) The tomato can be forced for winter bearing to advantage, but it demands close and constant attention.

(2) A tomato house should be very light and warm, and the roof should be at least 5 feet above the beds or benches.

(3) An abundance of sunlight is essential.

(4) The temperature should be about 60° to 65° at night and 70° to 80° during the day, or higher in full sunshine.

(5) House tomatoes demand a rich soil and a liberal supply of fertilizers.

(6) In this latitude house tomatoes bear when 4 to 5 months old.

(7) Tomatoes like brisk bottom heat. They may be grown in large boxes or upon benches; 18-inch-square boxes, placed about a foot apart and containing four plants to the box, afford one of the neatest and best means of growing tomatoes.

(8) Winter tomatoes must be trained. From one to three stems, depending upon the distance apart of the plants, are allowed to grow from each plant. These are trained upon perpendicular or ascending cords. The plants must be pruned as fast as new shoots appear. The heaviest clusters should be supported.

(9) Water may be used more freely early in the growth of the plant than later. Wet the soil thoroughly at each watering rather than water often. When the fruit begins to set, keep the atmosphere dry, especially during the middle of the day.

(10) In midwinter the flowers should be pollinated by hand. This may be done by knocking the pollen from the flowers when the atmosphere is dry and catching it in a spoon or other receptacle, into which the stigma is thrust.

(11) One-sidedness and much of the smallness of house tomatoes appears to be due, at least in part, to insufficient pollination.

(*a*) One-sidedness appears to result from a greater development of seeds upon the large side.

(*b*) This development of seeds is apparently due to the application of the pollen to that side.

(*c*) An abundance of pollen applied over the entire stigmatic surface, by increasing the number of seeds, increases the size of the fruit.

(*d*) The pollen probably stimulates the growth of the fruit, either directly or indirectly, beyond the mere influence of the number of seeds.

(12) The second crop of fruit is obtained by training out a shoot or shoots from the base of old plants, by burying the old plant, or by starting a new seedling crop. The first method appears to be the best.

(13) House tomatoes in this latitude yield about 2 pounds to the square foot. The amount of the first crop does not appear to influence the amount of yield in the second crop from the same plant.

(14) Lorillard, Ignotum, Volunteer, Ithaca, Golden Queen, and Beauty we have found to be good winter tomatoes.

(15) Insect pests are kept in check by fumigating with tobacco, and the spotted mite by Hughes' fir-tree oil. Fungi are controlled by ammoniacal carbonate of copper and Bordeaux mixture.

North Carolina Station, Annual Meteorological Report, 1890 (pp. 77).

ANNUAL REPORT OF THE METEOROLOGICAL DIVISION OF THE STATION FOR 1890, H. B. BATTLE, PH. D., AND C. F. VON HERRMANN.—This division of the station constitutes the North Carolina weather service. The report includes general statements regarding the work done in 1890; an annual summary of observations, comprising seven

tables compiled from the reports of forty-seven observers; and articles on the climate of North Carolina, tornadoes in North Carolina from 1826 to 1890, the formation and classification of clouds, and the origin of cold waves. The last three articles are reprinted from Bulletins Nos. 72*a*, 72*c*, and 73*b* of the station (see Experiment Station Record, vol. II, pp. 288 and 510). The article on the climate of the State is a preliminary report containing summaries of observations covering periods of from 8 to 19 years, in 11 tables. The following comparative summary of observations for 10 years is taken from the report:

Annual summaries of meteorological observations, 1881–90.

PRESSURE.

[In inches.]

Year.	Mean.	Highest.	Lowest.	Range.
1881	30.07	30.76, Feb., at Norfolk	29.17, Mar., at Norfolk	1.59
1882	30.10	30.86, Jan., at Norfolk	29.28, Feb., at Hatteras	1.58
1883	30.10	30.75, Feb., at Norfolk	29.18, Sept. 1, at Southport	1.57
1884	30.08	30.82, Jan. 27, at Lynchburgh	29.22, April 2, at Norfolk	1.60
1885	30.04	30.81, Jan. 3, at Lynchburgh	29.26, Oct. 29, at Norfolk	1.55
1886	30.05	30.80, Jan., at Lynchburgh	29.03, Jan., at Norfolk	1.77
1887	30.07	30.83, Dec. 1, at Lynchburgh	29.14, Aug. 20, at Hatteras	1.69
1888	30.10	30.79, Jan. 12, at Lynchburgh	29.22, Dec. 17, at Norfolk	1.57
1889	30.08	30.81, Feb. 24, at Lynchburgh	29.19, April 26, at Norfolk	1.62
1890	30.11	30.73, Jan. 28, at Hatteras	29.33, Dec. 17, at Lynchburgh	1.40

TEMPERATURE.

[Degrees F.]

Year.	Mean.	Highest.	Lowest.	Maximum range.	Mean daily range.	Mean maximum.	Mean minimum.
1881	59.7	107, Aug., at Weldon	–2, Jan., at Lynchburgh.	109			
1882	60.1	100, July, at Weldon	–6, Dec., at Ore Knob	106			
1883	60.1	102, July 23, at Weldon	–6, Jan., at Highlands	108	17.0	74.1	57.1
1884	60.1	100, July 24, at Chapel Hill.	–16, Jan. 6, at Knoxville.	116	18.1	70.5	52.4
1885	58.4	100, July 10, at Weldon and Chapel Hill.	1, Feb. 11, at Knoxville	99	17.3	67.2	49.9
1886	58.6	100, July 28, at Reidsville	–12, Jan. 11, at Lenoir	112	18.8	68.7	49.9
1887	59.1	107.1, July 18, at Kitty Hawk.	–4, Jan. 6, at Salem	111	18.1	69.0	50.9
1888	59.4	103, Aug. 2, at Weldon	6, Jan. 19, at Asheville	97	17.6	68.8	51.2
1889	59.4	100, July 10, at Kitty Hawk.	6, Feb. 7, at Asheville	94	17.7	68.2	50.0
1890	60.7	103, June 30, at Cheraw	4, Mar. 4, at Highlands	99	19.5	70.7	51.1

HUMIDITY.

Year.	Mean relative humidity.	Yearly rainfall.	Greatest monthly rainfall.	Least monthly rainfall.
	Per cent.	*Inches.*	*Inches.*	*Inches.*
1881	72.8	49.67	14.29, Dec., at Highlands	0.30, Aug., at Lynchburgh.
1882	75.2	55.50	16.98, Jan., at Knoxville	0.33, Oct., at Wadesborough.
1883	74.3	56.09	16.53, Sept., at Wilmington	0.10, July, at Brevard.
1884	74.8	54.31	14.53, Mar., at Brevard	0.05, Nov., at Flat Rock.
1885	75.6	51.20	12.85, Oct., at Flat Rock	0.75, Sept., at Washwoods.
1886	77.7	51.84	21.12, July, at Wilmington	0.02, Oct., at Kitty Hawk.
1887	73.8	52.09	22.73, Aug., at Tarboro	0.12, Nov., at Lincolnton.
1888	76.5	54.98	13.99, May, at Marion	0.27, April, at Washwoods.
1889	75.6	56.73	14.04, Suly, at Fayetteville	0.10, Dec., at Southport.
1890	75.2	46.49	14.48, July, at Highland	0.00, Nov., at Lenoir.

Annual summaries of meteorological observations, 1881–90—Continued.

WIND.

Year.	Movement per month.	Average hourly velocity.	Maximum velocity.	Prevailing direction.
	Miles.	*Miles.*	*Miles.*	
1881	6,422	8.8	76, N. E., April 14, at Kitty Hawk	N. E.
1882	6,704	9.2	72, N., Dec. 30, at Hatteras	S. W.
1883	6,596	9.0	93, S. E., Sept. 11, at Southport	N. E. and S. W.
1884	5,987	8.2	68, S. E., Jan. 8, at Fort Macon	N. E.
1885	6,086	8.3	98, S. W., Aug. 25, at Kitty Hawk	S. W.
1886	5,876	8.0	56, N., May 1, at Kitty Hawk	S. W.
1887	4,823	6.6	82, S. E., Aug. 29, at Hatteras	S. W.
1888	4,900	6.7	66, N., Nov. 25, at Hatteras	S. W.
1889	5,277	7.2	84, E., Mar. 19, at Kitty Hawk	S. W.
1890	5,491	7.4	63, N. E., Sept. 29, at Kitty Hawk	S. W.

WEATHER.

Year.	No. clear days.	No. fair days.	No. cloudy days.	No. rainy days.
1881	......	......	......	125
1882	110	155	100	145
1883	109	161	95	133
1884	119	150	97	[illegible]
1885	124	152	89	138
1886	125	148	92	127
1887	126	143	96	130
1888	129	122	115	121
1889	132	112	121	113
1890	135	125	105	107

Ohio Station, Bulletin Vol. IV, No. 1 (Second Series), January, 1891 (pp. 38).

EXPERIMENTS WITH CORN, C. E. THORNE AND J. F. HICKMAN, M. S. A.—This article reports in detail the experiments with corn conducted by the station in 1890, together with summaries of similar experiments in previous years. The subjects treated are, (1) tests of varieties; (2) distribution of seed; (3) planting of seed from different parts of the ear; (4) deep *vs.* shallow cultivation; (5) methods of harvesting; (6) tests of varieties of silage corn; and (7) field experiments with fertilizers at the station and elsewhere in Ohio. Previous accounts of experiments with corn may be found in the Annual Report for 1888 and in Bulletins vol. III, Nos. 2 and 3, of the station (see Experiment Station Bulletin No. 2, part II, p. 113, and Experiment Station Record, vol. II, pp. 121 and 165). "The season of 1890 was peculiarly unfavorable to corn, the almost incessant rains of spring and early summer interfering seriously with planting and cultivation, after which a severe drouth retarded growth." The average yield per acre in the test of varieties in 1889 was 69.5 bushels, while in 1890 it was only 57.6 bushels.

Corn, test of varieties (pp. 3–17).—The test of varieties at the station in 1890 was conducted on tenth-acre plats on fertile river bottom land. The stand obtained from the first planting (May 29) was so poor that

replanting (June 12) was necessary. Tabulated data for 38 varieties of dent corn (classified as large and medium yellow, mixed, and large and medium white) and for Brazilian Flour corn, include weight when husked, number of ears, shrinkage in drying, weight of shelled corn and of cobs, color of cob, yield per acre of grain and stalks, date of cutting, number of days from planting to cutting, and state of maturity. Data are also given for duplicate tests with four varieties in three counties representing different sections of the State. Other tables give averages of yields, etc., for the classes of varieties indicated above, and for 11 varieties for each of 3 years (1888–90), including the average yield as weighed in November and again in January. The per cent of shrinkage varied from 7 to 25. The rainfall and mean temperature at the station in each of 5 months (April-August) in 8 different years (1883–90) are also given. The total average rainfall during the 8 years was 17.48 inches, and the mean temperature 64.7° F. Brief descriptive notes are given for 33 varieties.

Corn, distribution of seed (pp. 17, 18).—Tabulated results of planting kernels from 9 to 49 inches apart and dropping from 1 to 4 grains at a time. The average yields for 3 years have been, with kernels 12 inches apart, 79.7 bushels per acre; 15 inches, 64.9 bushels; and 18 inches, 64.4 bushels. From planting at 6 inches apart in 1888 and 1889 an average yield of 101.9 bushels per acre was obtained, but nearly half (47 per cent) of these were nubbins.

Corn, seed from different parts of the ear (pp. 18–20).—"The seed used in this experiment has been grown continuously from the several parts of the ear, each year preserving the seed from the tips of ears grown from planting tips the year previous, middles from middles, and butts from butts, in like manner for three consecutive seasons [1888–90]." Results are tabulated for 1890 and for three other years (1886, 1888, and 1889) in which similar experiments were made. The average yields for the 4 years were, from the butts 66.9, middles 62.8, tips 64.8 bushels per acre.

Corn, deep vs. shallow cultivation (pp. 20, 21).—The average results of experiments in 1890 with deep and shallow cultivation, as given in a table, show a slight advantage in favor of the latter method. Similar experiments in 1888 and 1889 slightly favored the former method.

Corn, methods of harvesting (pp. 21–24).—Experiments at this station and in three other places in Ohio are reported, in which the corn on some of the experimental plats was cut and shocked in the ordinary way and at the ordinary season; on others it was topped; and on others it was allowed to mature on the stalk. The results, as tabulated, are contradictory.

Corn, test of varieties for silage (pp. 24, 25).—The yields are given for nine varieties grown on fertile soil in 1889, and on poor soil in 1890. The corn was planted June 7 and 19, and was cut September 27. "In neither year were the varieties of corn sufficiently matured to make

first-class silage, except the Early Sanford, and this variety is not sufficiently productive to justify its general introduction for silage purposes."

Corn, field experiments with fertilizers (pp. 25–37).—A report on experiments in 1890 at the station and by three farmers in as many counties of the State. The plan followed was in general that described in Bulletin vol. III, No. 2, of the station (see Experiment Station Record, vol. II, p. 122). The results are stated in tables, and compared with those of 1889. In every case where barnyard manure was used, there was an increase of from 2.9 to 26.4 bushels in the yield. The results from the use of superphosphate, muriate of potash, and nitrate of soda, singly and in combination, were quite variable, and in general confirmed the tentative conclusions drawn from the previous experiments. Valuing corn at an average of 33⅓ cents per bushel, the increase in yield due to the use of fertilizers was not sufficient to pay their cost in any of the tests of 1890.

Corn, summary of experiments (pp. 37, 38).—The following statements are taken from the summary given in the bulletin:

(1) From the large yellow dent class, only a few are recommended for Ohio soil, namely, Big Buckeye, Leaming, Leaming Improved, Murdock Yellow Dent, and Woodworth Yellow Dent. From these the Leaming or Leaming Improved might be selected as the most prolific. The Clarage from among the medium dents and the Butcher corn from the mixed dents, are both good varieties and will mature in an ordinary season. Briar Crest Beauty, Chester County Mammoth, Golden Beauty, Golden Dent, and Cloud Early Dent are large and productive varieties, but can not be relied upon to mature on Ohio soils. Golden Dent and Golden Beauty are believed to be one and the same variety. * * *

(2) The results of previous experiments are confirmed by the work of this year, in showing that more and better corn can be raised to the acre where the stalks average 12 inches apart than where they are at less or greater distances. The results in general are as good when the corn is planted in hills as when planted in drills, when the average distances of the grains or stalks are the same.

(3) The results of a 4 years' comparative test fail to show any marked superiority in the productiveness of seed taken from the butt, middle, or tip of the ear.

(4) The results of 2 years' experiments are slightly in favor of shallow culture.

(5) The exact stage of maturity at which corn is cut may materially affect its final yield per acre.

(6) Red Cob Ensilage, Blount White Prolific, and B. and W. are good varieties for the silo. Early Sanford and sweet fodder corn are not as a rule profitable in this State for silo purposes. * * *

(7) The results of 2 years' experiments, conducted on the station farm and in various sections of the State, indicate that in Ohio the use of commercial fertilizers on corn, at present prices of grain and fertilizers, is likely to result in loss more often than in profit.

Ohio Station, Bulletin Vol. IV, No. 2 (Second Series), February, 1891 (pp. 19).

MISCELLANEOUS EXPERIMENTS IN THE CONTROL OF INJURIOUS INSECTS, C. M. WEED, D. SC. (pp. 39–47).—Brief accounts of experiments, (1) by the author with Bordeaux mixture combined with Paris green or London purple, and with ammoniated carbonate of copper and

Paris green, in which no injury was done to the foliage of fruit trees, grapevines, or potatoes; (2) by the author with Paris green, London purple, or lime and London purple applied to pear and apple trees, in which it appeared that Paris green did little injury to foliage; London purple alone did much injury, but this was largely prevented by the addition of lime to the solution of London purple; (3) by two Ohio fruit growers with London purple for the plum curculio, in which injuries by the insect were largely prevented, but the foliage was considerably damaged; (4) by three Ohio fruit growers with dilute whitewash for the rose chafer (*Macrodactylus subspinosus*), with varying success; (5) by several farmers with various remedies for the striped cucumber beetle (*Diabrotica vittata*); (6) by the author with tobacco powder used successfully for plant lice on lettuce.

Some common cabbage insects, C. M. Weed, D. Sc. (pp. 47–52, figs. 6).—Notes on the imported cabbage worm (*Pieris rapæ*), cabbage plusia (*Plusia brassicæ*), zebra caterpillar (*Ceramica picta*), wavy-striped flea beetle (*Phyllotreta vittata*), and cabbage cutworms, with illustrations after Riley.

Three important clover insects, C. M. Weed, D. Sc. (pp. 53–55, figs. 3).—Notes on the clover root borer (*Hylastes trifolii*), clover seed midge (*Cecidomyia leguminicola*), and clover hay worm (*Asopia costalis*), with illustrations after Riley.

Texas Station, Bulletin No. 14, March, 1891 (pp. 15).

Effects of cotton seed and cotton-seed meal on the creaming of milk, G. W. Curtis, M. S. A., and J. W. Carson (pp. 61–73).—The following experiments were made to study the effect of cotton seed or cotton-seed meal when fed to milch cows, on the completeness of the separation of the cream. This effect was studied in cases where the cream was raised by setting the milk in Fairlamb cans at 70° or at 45° F., and where the creaming was effected by a De Laval separator, each test being made with cows somewhat advanced in the milking period and with others comparatively new milch. "The selections of cows were made with special reference to length of time since calving and to uniform individual quality as determined by previous test. * * * Each animal was carefully watched throughout the entire test, and at once withdrawn on the appearance of the least abnormal indication, whether of appetite, general health, or condition."

Three separate experiments were made in which the milk was set, as soon as milked, in Fairlamb cans, without ice, and kept as nearly as possible at a temperature of 70° F. until sour (12 to 24 hours), when it was skimmed. Each of these experiments represented a different stage of the lactation period. Thus the 10 cows in the first experiment had calved 104 to 124 days, the 8 in the second experiment 88 to 93 days, and the 6 in the third experiment 49 to 51 days previous to the beginning of the trial. In each experiment the cows were divided

into two lots as nearly equal as possible, and while those of one lot received equal parts of corn-and-cob meal and bran, those of the other received equal parts of cotton-seed meal and bran. The coarse fodder was the same for both lots in each experiment and consisted variously of hay and pasturage, silage, or silage, pasturage and sorghum. The amounts of food given and the duration of the experiments are not stated. The milk for each lot was mixed and set by itself. After the feeding had been continued for 12 days, samples of the whole milk and skim milk were taken for analysis. The fat in the whole milk was determined by the Patrick milk test, and that in the skim milk by the Adams gravimetric method. The results of these analyses, and the percentage of the total fat which was left in the skim milk, are tabulated for each lot in each experiment. The averages of these results are given below:

Milk set in cans at 70° F.

	Number of days since last calving.	Without cotton-seed meal.			With cotton-seed meal.		
		Fat in whole milk.	Fat in skim milk.	Per cent of total fat left in skim milk.	Fat in whole milk.	Fat in skim milk.	Per cent of total fat left in skim milk.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
First experiment	104-124	5.22	1.63	30.9	5.89	1.10	18.4
Second experiment	88-93	4.08	1.28	31.8	3.98	0.91	22.9
Third experiment	49-51	4.40	0.64	14.9	4.18	0.47	11.3

As will be seen, the separation of the fat by setting at 70° F. was more complete from the milk of the cows receiving cotton-seed meal than from that of those receiving corn-and-cob meal. "That the effect is in no sense due to individual peculiarity of cows, is proven, we think, satisfactorily by the fact that different sets of cows were used in the tests represented by each separate table, as above given, the food condition showing itself uniformly the same with different sets."

Three other trials were made, in which the milk was set in cans at 45° F., this temperature being maintained by the use of ice costing 1 cent per pound. In the first two trials the same 10 cows were used, the milk being skimmed in one experiment after 12 hours and in the other after 24 hours' setting. The third experiment was with 8 cows nearly fresh in milk, and the skimming took place after 24 hours' setting. In each experiment the cows were divided into two lots, one lot receiving equal parts of corn meal and bran, while the other received equal parts of cotton-seed meal and bran. The coarse fodder consisted in all cases of silage and pasturage.

The averages of the results stated are as follows:

Milk set in cans at 45° F.

	No. of days since last calving.	Without cotton-seed meal.			With cotton-seed meal.		
		Fat in whole milk.	Fat in skim milk.	Per cent of total fat left in skim milk.	Fat in whole milk.	Fat in skim milk.	Per cent of total fat left in skim milk.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Skimmed after 12 hours	125–145	4.22	2.07	49.1	4.34	1.38	31.7
Skimmed after 24 hours	132–152	4.34	1.67	37.6	4.86	1.11	22.9
Skimmed after 24 hours	30–34	4.53	0.96	21.3	4.27	0.34	7.9

Here again the percentage of fat left in the skim milk was least with the cows receiving the cotton-seed-meal ration. The separation of the cream was in all cases more complete with 24 hours' setting than with 12 hours.

The results of both series of experiments indicate further that the separation of cream by setting milk in cans was less perfect when the cows were advanced in the lactation period than when they were nearly fresh. The influence of the stage of the milking period in this respect was very marked, whether the food contained cotton-seed meal or not. The results indicate no particular advantage of setting at 45° over 70°.

From the results of an experiment with 4 new milch cows, made to compare the effects of cotton seed with those previously observed for cotton-seed meal on cows likewise new milch, the authors conclude that "there is practically no difference between the effects of cotton seed and cotton-seed meal so far as gravity creaming is concerned."

To determine whether cotton-seed meal has any effect on the separation of the cream by means of the centrifugal apparatus, 8 cows were fed the corn-meal-and-bran ration, and 8 others, at the same stage of lactation, the cotton-seed-meal-and-bran ration. The milk of these cows was separated by a De Laval power separator as soon as milked. The average results were as follows:

Cream separated centrifugally.

	No. of days since last calving.	Without cotton-seed meal.			With cotton-seed meal.		
		Fat in whole milk.	Fat in skim milk.	Per cent of total fat left in skim milk.	Fat in whole milk.	Fat in skim milk.	Per cent of total fat left in skim milk.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
I	210	4.67	0.08	1.8	4.39	0.10	2.3
II	59–63	3.88	0.13	3.27	3.84	0.13	3.3

"It will be seen that there is really no difference in machine creaming due to food effect."

Utah Station, Bulletin No. 6, May 15, 1891 (pp. 14).

TRIALS OF SLEDS AND TILLAGE TOOLS, J. W. SANBORN, B. S.—Notes and tabulated data on tests of various kinds of sleds and harrows with the dynamometer and in other ways. The following summary is taken from the bulletin:

(1) In the trial made, sleds drew harder than wagons over the same ground the previous fall under what seemed to be equally favorable conditions for each.

(2) Change of load from the front to the rear end of the sled did not materially affect draft, as it did with wagons.

(3) The friction due to the point of hitch of the horses or the relation of the power to the load did not follow the same law as with wheels. The hitch for sleds seems to be too low down as now made.

(4) A load draws as easy with crooked shaft as with a straight hitch.

(5) Draft varied with the sleds used and was least on the shortest sled, but it is not certain that the length of sled was the determining cause in the trials made. No other solution of the facts found was discovered. Future inquiry will be necessary to determine with certainty the cause of the variations in draft between the makes of sleds used.

(6) Depth of cutting the ground, draft per square inch and per pound of soil moved, looseness of soil, and evenness of bottom varied very widely in the various types of harrows used.

(7) The rolling cutters, especially those termed cutaway harrows, move the soil deepest and loosen it most, and in the form of the cutaway harrow draw the easiest of the class that penetrates deeply.

(8) The spring-toothed harrows draw moderately "fine" to an average degree, and till to an average depth, but leave the soil with an uneven bottom and more compact than the class above named, while on newly plowed grass sward they tear up the sod. For the cultivation of corn, they are very good implements, serving well the functions required in tillage of crops.

(9) The square-toothed and the smoothing harrows are superficial in their action on plowed ground, run easy, but compress the soil more than other classes, and are therefore better adapted to loose soils and for putting in seeds than to do the tillage work of soil fitting for crops. If present views regarding tillage are correct, then these implements are utterly unfitted for the purpose when applied to most soils.

(10) When depth of cutting, ease of draft, evenness of bottom or of the top of the unstirred soil, and looseness of soil are considered, the cutaway type of harrows is the best of the several classes of tillage tools used by the writer for the preparation of the average soil for crops. It is believed that the work of this class of harrows should always be supplemented by the smoothing harrow.

(11) Harrows move less earth for a given amount of force than plows do, but, as found in a previous trial, the force required for fitting the soil for crops, when the plow supplemented by the harrow, is used is practically no less than when the harrow alone is used.

(12) Less force is required to fit a given surface area of soil for crops when the harrow is used than when the plow is used. This fact admits of the use of some substitute for the plow upon soils that do not require deep tillage, if, indeed, there are such soils.

(13) The relative efficiency of harrows varies on varying soils and on varying conditions of a given soil, the wedge-shaped teeth being at greatest disadvantage on hard soils.

(14) The plow, acting as a wedge, compresses the particles nearer together as it inverts the soil and divides only large masses; therefore the harrow is the true implement for "fining" and loosening the soil, the plowing serving to fit the soil for its

action. Except upon grass ground, it is not improbable that the harrow, somewhat modified, may grow in importance when compared with the plow, unless the plow becomes modified for special soils.

Vermont Station, Bulletin No. 24, May, 1891 (pp. 16).

POTATO BLIGHT AND ROT, L. R. JONES, B. S. (pp. 19–32).—Brief accounts of successful experiments in spraying potato vines with Bordeaux mixture for potato rot (*Phytophthora infestans*). In one experiment in 1890 a plat which was sprayed twice yielded 165 bushels of sound tubers, another sprayed once yielded 155 bushels, while a third plat twice as large as either of the other two, which was left unsprayed, yielded only 86 bushels. It was found feasible and desirable to combine the Bordeaux mixture with the Paris green used for potato bugs. Attempts were made to disinfect tubers before planting by heating them for a number of hours in a dry oven at 107½° to 109½° F., in sealed jars at 106° to 108° F., or by soaking them in water at 106° to 108° F., or in solutions of sulphate of copper. The heating in a dry oven seems to have been beneficial, but the other treatments were more or less injurious. Examinations of samples of a number of varieties of potatoes showed that in these cases the dry rot was worse at the seed end than at the stem end. Details of the investigations on potato rot will be published in the Annual Report of the station for 1890.

Vermont Station, Bulletin No. 25 (pp. 4).

THE BOUNTY ON MAPLE SUGAR, W. W. COOKE, M. A. (pp. 33–36).—An explanation of the conditions under which the farmer can secure the bounty for maple sugar offered by the national Government in accordance with a recent act of Congress. Tests made at the station indicate that most of the sugar made in the State during the early and middle parts of the season will test over 80 degrees by the polariscope, and thus come up to the standard required by the law. The station is making investigations with reference to methods of making maple sugar, and will publish the results in a future bulletin.

West Virginia Station, Bulletin No. 13, January, 1891 (pp. 63).

THE CREAMERY INDUSTRY, J. A. MYERS, PH. D. (plates 1, figs. 6).—A reprint of an article on this subject published in the Annual Report of the station for 1890, pp. 29–88, an abstract of which was given in Experiment Station Record, vol. III, p. 44.

West Virginia Station, Bulletin No. 14, February, 1891 (pp. 17).

FARM AND GARDEN INSECTS AND NOTES OF THE SEASON, A. D. HOPKINS (pp. 65–79).—This is a reprint of articles published in the Annual Report of the station for 1890, pp. 145–159 (see Experiment Station Record, vol. III, p. 46).

West Virginia Station, Bulletin No. 15, March, 1891 (pp. 6).

RASPBERRY GOUTY GALL BEETLE, A. D. HOPKINS (pp. 81–84, plate 1).—A reprint of notes on *Agrilus ruficollis* published in the Annual Report of the station for 1890, pp. 160–163 (see Experiment Station Record, vol. III, p. 46).

West Virginia Station, Bulletin No. 16, April, 1891 (pp. 11).

LOCUST TREE INSECTS, A. D. HOPKINS (pp. 85–91, plate 1).—A reprint of an article published in the Annual Report of the station for 1890, pp. 164–170 (see Experiment Station Record, vol. III, p. 47).

West Virginia Station, Bulletin No. 17, May, 1891 (pp. 12).

PRELIMINARY REPORT ON BLACK SPRUCE INSECTS, A. D. HOPKINS (pp. 93–102).—A reprint of an article published in the Annual Report of the station for 1890, pp. 171–180 (see Experiment Station Record, vol. III, p. 47).

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF BOTANY.

CONTRIBUTIONS FROM THE U. S. NATIONAL HERBARIUM, VOL. I, NO. 4, JUNE 30, 1891.

LIST OF PLANTS COLLECTED IN WESTERN MEXICO AND ARIZONA, J. N. ROSE (pp. 91–127, plates 10).—This includes lists of plants collected by Dr. Edward Palmer in western Mexico (at Alamos) and Arizona in 1890, with descriptive notes on 45 new species and several new varieties. The new species illustrated in the plates accompanying the bulletin are, *Stellaria montana*, *Diphysa racemosa*, *Echinopepon cirrhopedunculatus*, *Tithonia fruticosa*, *Bidens alamosanum*, *Hymenatherum anomalum*, *Perezia montana*, *Cordia sonoræ*, *Ipomœa alata*, and *Tabebuia palmeri*.

Among the plants of this collection are many very beautiful ones which should claim the attention of cultivators. Of these we cite *Heteropterys portillana*, a recent species described by Mr. Watson. This is especially attractive for its large clusters of red fruit. It is very common at Alamos, and could easily be obtained for cultivation.

Galphimia humboldtiana, a rare plant in herbaria, is a common and attractive shrub of the mountains here. It is 6 to 8 feet high, with a handsome top, large racemes of yellow flowers, and attractive foliage.

Cordia sonoræ is a new species, a very beautiful shrub or small tree, and an abundant bloomer.

Tabebuia palmeri, another new species, is a conspicuous tree of this region. It grows to the height of 25 feet and produces large clusters of flowers.

Three or four of the Ipomœas are very attractive; one is a tree 30 feet high; another is a climbing shrub (*I. bracteata*), with large, conspicuous bracts, which give the plant a very showy appearance; two other new species are high-climbing vines.

CONTRIBUTIONS FROM THE U. S. NATIONAL HERBARIUM, VOL. II, NO. 1, JUNE 27, 1891.

MANUAL OF THE PHANEROGAMS AND PTERIDOPHYTES OF WESTERN TEXAS, POLYPETALÆ, J. M. COULTER (pp. 156, plate 1).—This is the first part of a manual intended to include descriptions of all Texan plants west of the ninety-seventh meridian. The rich flora of this region has never before been systematically described. It is believed that the manual will be of service to botanists and students not only

in Texas, but also in other large regions of the Southwest, which have a more or less similar flora. As far as practicable, the geographical range of the different species is indicated. This part, which embraces only the Polypetalæ, contains descriptions of 765 species in 271 genera belonging to 50 orders. The great orders are the Leguminosæ, represented by 203 species in 52 genera; Cactaceæ, 71 species in 4 genera; Malvaceæ, 53 species in 14 genera; Umbelliferæ, 50 species in 29 genera; Cruciferæ, 48 species in 18 genera; Onagrarieæ, 38 species in 6 genera; Rosaceæ, 28 species in 13 genera. The single plate accompanying this bulletin illustrates *Thelypodium vaseyi*, Coulter.

DIVISION OF FORESTRY.

Bulletin No. 5.

What is forestry? B. E. Fernow (pp. 52).—This is a popular statement of the general principles of forestry, taken mainly from addresses delivered by the author before representative bodies. The subject is treated in three chapters, viz: The Forest and its Significance, Forestry in a Wooded Country or Forestry Management, and Forest Planting in a Treeless Country. The topics considered under forestry in a wooded country are: The objects of forest management, where forest growth should be maintained, what forest management is and what it is not, reproduction of trees, improvement of tree crop—thinning, undergrowth, mixed growth—light influences, special considerations in thinning, European government forestry, administrative considerations, working plans, and profitableness of forest management. The author takes a conservative view of the methods which should be immediately adopted in this country for the management of our forests.

Forestry in a wooded country means harvesting the wood crop in such a manner that the forest will reproduce itself in the same if not in superior composition of kinds. Reproduction then is the aim of the forest manager, and the difference between the work of the lumber man and that of the forester consists mainly in this: That the forester cuts his trees with a view of securing valuable reproduction, while the lumberman cuts without this view, or at least without the knowledge as to how this reproduction can be secured and directed at will. * * *

The administrative measures in vogue in European forest management we may perhaps not think desirable or suitable to our country and conditions, but the technical measures, as far as they are based upon natural laws and by experience proved proper for the object in view, will have to be adopted, with the necessary modifications, if we wish to attain proper forest management.

However, before we may apply the finer methods of forestry management as practiced abroad, it will be well enough to begin with common-sense management, which consists in avoiding unnecessary waste, protecting against fire, keeping out cattle where young growth is to be fostered, and not preventing by malpractice the natural reforestation.

The financial side of forestry abroad is illustrated in the following table. The marked differences in expenditures and revenues are stated

to be due "to differences of market facilities and intensity of management, and also to forest conditions:"

Countries.	Forest area.	Total expenditure.	Revenue.		Expenditures and revenues per acre of forest.						
					Expenditures.						
			Gross.	Net.	Total.	Gross income.	Administration and protection.	Marketing crop.	Cultivation.	Roads.	Net revenue.
	Acres.					*Per ct.*					
Prussia	6,000,000	$8,000,000	$14,000,000	$6,000,000	$1.33	58	$0.48	$0.30	$0 14	$0.06	$0.96
Bavaria	2,300,000	3,150,000	5,880,000	2,730,000	1.37	53	0.64	0.37	0.11	0.11	1.19
Würtemberg	470,000	1,025,000	2,260,000	1,235,000	2.17	45	0.87	0,92	0.22	0.23	2.63
Saxony	416,000	1,040,000	2,750,000	1,710,500	2.50	37	0.65	0.81	0.11	0.21	4.11
Baden	235,000	404,000	1,090,000	686,000	1.54	40	0.22	0.83	0.15	0.12	2.90
City of Zurich	2,760	14,000	26,000	12,000	5.00	54	1.14	2.10	0.16	1.14	4.40

In the chapter on forest planting in a treeless country, the topics considered are, forest cover and moisture, need of coöperative action, how to plant, relation of tree growth to light, how to mix species of trees, conifers, methods of planting, and forest planting as a work of internal improvement. The general principles on which experiments in tree planting on the plains should be made are summed up as follows:

(1) Forest plantations in large blocks have more chance of success than small clumps or single trees, since large plantations alone are capable of becoming self-sustaining and of improving their conditions of growth by their own influence upon moisture conditions of the soil and air.

(2) We must not only plant densely (much more densely than is the common practice), but in the selection of kinds give predominance to such as are capable of quickly and persistently shading the ground, creating an undergrowth and cover that will prevent evaporation, and thus make possible the planting of the light-foliaged, quick-growing, valuable timbers.

Twelve kinds of trees used in prairie planting are grouped as follows, according to their shade endurance, and their rate of height growth during their youth:

As to shade.	*As to rate of height growth.*
(1) Box elder.	(1) Cottonwood.
(2) Mulberry.	(2) Soft maple.
(3) Elm.	(3) Elm.
(4) Black cherry.	(4) Locust.
(5) Osage orange.	(5) Honey locust.
(6) Catalpa.	(6) Black cherry.
(7) Soft maple.	(7) Catalpa.
(8) Locust.	(8) Osage orange.
(9) Honey locust.	(9) Box elder.
(10) Black walnut.	(10) Black walnut.
(11) Ash.	(11) Ash.
(12) Cottonwood.	(12) Mulberry (?).

This is not an immutable scale, but only a tentative proposition, and for the purpose of illustration, in which the kinds placed widely apart will alone really retain their relative positions. We will find at the top of the first scale the most shade-enduring and at the head of the second scale the most rapid growing among those named. If we can make, therefore, a combination of these, we will succeed in obtaining the two points to be gained—the densest crown cover in varying tiers, and the light-needing kinds overgrowing the shade-enduring, which allows the largest number of individuals on the area. * * *

Of all trees, the most suitable for prairie planting and for planting in the dry plains are beyond doubt the conifers, especially the pines.

There are two reasons why they should be chosen preferably to others: First of all, they furnish not only a denser cover, lateral and vertical, but a cover all the year around, being evergreen. Secondly, they require less water, from one sixth to one tenth, than most deciduous trees, and are therefore less liable to succumb to drouth. In winter they will hold the snow more efficiently than the naked, leafless kind, thus preserving the moisture on the ground.

Nature has given us indications in that direction. The driest soils everywhere are occupied by the pines, and the arid slopes of the Rocky Mountains and the interior basin support only conifers, especially pines and junipers. From Professor Bessey I learned only to-day that my theory regarding the former forest cover of the plains is borne out by the discovery of pine forests buried in the sand hills of northern Nebraska; and that he found growing naturally in eastern Nebraska the same kind of pine that covers the Black Hills and Rocky Mountain slopes, namely, the bull pine (*Pinus ponderosa*).

Articles setting forth the results of personal experiences in tree planting on the Dakota plains are appended to the bulletin, the authors being A. M. Thomson and J. W. Smith.

OFFICE OF EXPERIMENT STATIONS.

Experiment Station Bulletin No. 2, Part II.

Digest of the Annual Reports of the Agricultural Experiment Stations in the United States for 1888 (pp. 173).—This contains a digest of the reports of the stations in Kansas, Kentucky, Maine, Maryland, Minnesota, New Hampshire, Ohio, Pennsylvania, Rhode Island, South Carolina (part II), and West Virginia, which reports were not received by the Office until after the publication of part I of this bulletin. Separate indexes of names and subjects accompany each part of the digest.

Miscellaneous Bulletin No. 3.

Proceedings of the Convention of American Agricultural Colleges and Experiment Stations at Champaign, Illinois, November, 1890 (pp. 156).—This is edited by A. W. Harris for this Office, and H. E. Alvord for the Association. Besides minutes of the general and sectional sessions, the papers read are given in full or by abstracts. For a brief account of the convention, with the titles of papers, see Experiment Station Record, vol. II, p. 265.

DIVISION OF GARDENS AND GROUNDS.

Papers on horticultural and kindred subjects, W. Saunders (pp. 124).—These are reprinted from reports of the Department of Agriculture, 1863–89, and include articles on the following subjects: Landscape gardening, draining lands, sowing seeds and raising young plants of forest trees, making and keeping lawns, spring and fall planting of trees, keeping hedges, cultivation, mechanical preparation of soil, mulching, situations for orchards, orchard planting, management of orchards, pruning, remarks on pear culture, native grapes, grapes—mildew, propagating native grapes, foreign grapes in glass structures, inside borders for graperies, thrips on grapes, propagating by cuttings, sowing seeds, seed saving, rotation in cropping, expedients for promoting fruitfulness in plants, importance of a uniform supply of water in plant culture, liquid manure for plants in pot culture, flower pots, night temperature in glass structures, watering plants in pots, water plants, glazing greenhouse roofs, raspberry culture, figs, vanilla, India rubber plants, citron, special inquiries and answers, well-ripened wood, and notes on orange culture and the pineapple.

DIVISION OF STATISTICS.

Report No. 86 (new series), July, 1891 (pp. 303–374).—This includes articles on the condition and acreage of corn, wheat, oats, rye, barley, cotton, potatoes, tobacco, grasses, and fruit, July 1, 1891; the weight of wool per fleece; reports of State agents; European crop report for July; European rye production; the coöperative credit unions or people's banks of Germany; agriculture in Peru; and transportation rates.

Rye in Europe is a cereal second in importance to wheat only. In many countries it is the staple breadstuff, its use making possible a larger exportation of wheat from exporting countries, and supplementing the higher-priced cereal in importing countries. In eastern Europe the product is larger than the wheat crop in Austria, Germany, and Russia. The crop in Russia is larger than any cereal crop grown in any country of the world, except corn in the United States.

The rye crop of Europe.

[In Winchester bushels.]

Countries.	1887.	1888.	1889.
Austria-Hungary:			
Austria	91, 031, 114	81, 570, 776	70, 780, 870
Hungary	51, 295, 798	42, 195, 395	36, 789, [illegible]
Belgium	18, 182, 505	15, 047, 047	18, 117, [illegible]
Denmark	16, 690, 138	15, 685, 483	17, 329, 012
France	67, 182, 673	62, 957, 045	65, 622, 312
Germany	250, 998, 981	217, 418, 451	211, 146, [illegible]
Ireland	232, 686	374, 104	406, 870
Italy	4, 330, 791	3, 648, 835	3, 831, 956
Netherlands	13, 776, 063	....	....
Portugal	....	....	6, 437, 340
Roumania	....	....	10, 305, 431
Russia in Europe, except Poland	744, 192, 075	706, 646, 588	551, 525, 600
Poland	....	47, 887, 247	37, 500, 763
Servia	....	2, 600, 000	....
Spain	....	....	24, 803, 155
Sweden	22, 405, 845	19, 955, 286	20, 924, 576

FIBER INVESTIGATIONS, REPORT NO. 3.

SISAL HEMP CULTURE, C. R. DODGE (pp. 59, plates 8, figs. 21).—This includes a brief history of the culture of sisal hemp in Florida; notes on the soil, climate, and cultivation adapted to these plants, and on rate of growth, harvesting, and yield per acre; descriptions of machinery for extracting the fiber; an account of the present condition of the industry in Florida; notes on other leaf fibers (*Agave americana*, *A. mexicana*, and *Sanseviera zeylanica*) observed by the author in Florida; compiled notes on *Agava rigida*, var. *sisalana*, and on the sisal hemp industry in the Bahamas.

The imports of sisal hemp fiber into this country from Yucatan for the fiscal year ending June 30, 1890, amounted to 28,312 tons, in round numbers, worth $4,330,300; and for the year previous the imports amounted to over 35,000 tons. This does not take into account the imported manufactures from sisal hemp, which are considerable, the value of which can not be given. It is said that the United States purchases over 80 per cent of the marketable fiber produced in Mexico.

The fact that the sisal hemp plant can be grown in this country in any quantity, as far as the mere question of cultivation is concerned, was satisfactorily demonstrated many years ago. Over 50 years have passed since the plant was introduced into Florida by Dr. Henry Perrine, and it is now growing wild in many portions of the State.

Sisal hemp is now extensively grown in Mexico and has been successfully introduced into Cuba and the Bahamas. There is reason to believe that it can be profitably grown in southern Florida.

A rapid method for estimating nitrates in potable waters, George Harrow (*Jour. Chem. Soc.*, 59, *pp.* 320–323).—The author sought to devise a method for the estimation of nitrates which should be as rapid as Nessler's test is for the determination of ammonia. The method which he proposes depends on the conversion of nitric acid into nitrous acid by means of zinc dust, and the estimation of the nitrous acid by the Griess test (α-napthylamine and sulphanilic acid). The test reagent is prepared by dissolving 1 gram α-napthylamine, 1 gram sulphanilic acid, and 25 c. c. strong hydrochloric acid, in about 200 c. c. of distilled water, boiling with a small quantity of animal charcoal, filtering, and then making up to 500 c. c. Standard solutions containing respectively 1, 0.1, and 0.01 part of nitrogen as nitrates per 100,000 are made by dissolving 0.721 gram of pure dry potassium nitrate in 1 liter of water (=10 parts of nitrogen per 100,000 c. c.), and diluting to the required strength.

The manner of making the test is described as follows: Fifty c. c. of each water to be tested (as many as four estimations may readily be made at the same time) are placed in beakers of about 100 c. c. capacity, and 50 c. c. of each of the standard nitrate solutions in smaller beakers. Ten c. c. of the test reagent are added to each beaker, and afterwards a small quantity of zinc dust (7–8 mg.). If nitrites are present in the water the pink color will appear without the addition of zinc dust (Griess's test). If nitrates are present a more or less intense pink color will appear on the addition of the zinc dust, and after about 15 minutes the intensity of the color is compared with that of the three standard nitrate solutions, the water being diluted until its color corresponds with that of one of them. The author suggests that perhaps the greatest accuracy may be secured by comparing with the most dilute standard, in which case it may frequently be necessary to dilute the water a hundredfold. The necessary dilution being indicated by this preliminary test, the test is repeated with diluted water, the comparison of color with that of the standard chosen being made after 15 minutes in graduated Nesslerizing tubes of equal caliber, as follows: "The standard solution occupying 60 c. c. in one cylinder, the water tested is run into the other until the depth of the color appears to be equal. A reading is then made of the quantity necessary. Say 45 c. c. were employed; then $45 : 60 :: 0.1 : x$ (=0.133), and supposing the water to have been ten times diluted, it would contain 1.33 parts nitrogen as nitrates and nitrites [per

100,000]." The tabulated results of comparisons of this new method with the Crum mercury method as modified by Frankland and Armstrong on numerous samples of water, show the new method to give results in most cases slightly higher than the mercury method; this error amounted in only one instance to 0.4 part of nitrogen in 100,000, and was usually below 0.2 part.

The advantage claimed for the test are rapidity, simplicity, and ease of execution, and the small quantity of water required for the determination, 20 c. c. being sufficient. The only precaution mentioned is to avoid the addition of large quantities of zinc dust, as they decolorize the solution.

Absorption of atmospheric ammonia by arable soils, T. Schlösing (*Compt. rend.*, 110 (1890), *pp.* 429 *and* 499).—Previous experiments by the author and by other investigators have indicated that arable soils absorb considerable quantities of ammonia from the air, but the conclusions have not been universally accepted. During the years 1886–90, twenty-five experiments were instituted by the author for the further study of the problem.

Specimens of different kinds of soil were placed in shallow, circular, flat-bottomed glass vessels with a superficial area of 2 square dm., and a depth varying with the weight of the soil. As a certain amount of nitrogen would be brought to the soils in atmospheric dust, one vessel was left empty and the nitrogen determined in the dust collected in it. All these vessels were placed inside an apparatus arranged to provide for circulation of air. Two other vessels of the same kind containing dilute sulphuric acid were placed one inside the apparatus and the other in open air. The amounts of ammonia absorbed by the acid in the two vessels were compared to obtain an indication of the amounts of atmospheric ammonia which would come in contact with the soil of the experiments as compared with the amounts which would come in contact with ordinary cultivated soils. In estimating the amount of nitrogen gained by the different soils under experiment, a correction was made for the amount of nitrogen in the atmospheric dust. It was found that the acid in the vessel placed near those containing the soils under experiment inside the apparatus, through which a more or less constant current of air was passing, absorbed more ammonia than had been found to be absorbed by acid exposed to the open air. The inference was that more atmospheric ammonia had been brought in contact with these soils than would be the case with ordinary cultivated soils. A correction for ammonia contact was therefore made in the figures for total gain of nitrogen by the soils. This correction, which varied with the different soils, was much larger than that for atmospheric dust. The figures quoted below for the annual gain of nitrogen per hectare are those obtained after the subtractions for both atmospheric dust and ammonia contact.

Determinations were made of the amount of nitrogen in the forms of ammonia, nitric acid, and total nitrogen in each soil at the beginning, from time to time during, and at the end of the experiment. The amounts of gain or loss in each specimen were thus learned and the corresponding amounts per hectare were calculated. The author urges, however, that the excess of ammonia in the soil at the end over that at the beginning of the experiment does not represent the amount of ammonia absorbed, since part of it is used for the formation of complex nitrogenous compounds, and is not transformed into ammonia and dissolved by the dilute acid used for extracting and determining the amounts of ammonia in the soil. More or less of the ammonia would of course be changed to nitric acid.

The twenty-five experiments were divided into four groups:

(1) The first group included six non-calcareous soils, which had served as material in previous experiments by the author on the fixation of the free nitrogen of the air. Since no gain of nitrogen had been found in either of these soils in the previous experiments, it was assumed that any gain which should be found in the present experiments must be attributed to the absorption of nitrogen compounds from the air. The soils were kept moist during experimental periods of from 495 to 622 days. One was nearly covered, and showed no considerable gain of nitrogen. In the other five the gain ranged from 15.3 to 50.1 kg. per hectare, or from 13.7 pounds to 45.1 pounds per acre per year.

(2) The second group included three experiments, one with a calcareous soil, the other two with a non-calcareous soil and subsoil. The experiment continued 115 days from May 4. The soils were moistened daily. The calcareous soil gained nitrogen at the rate of 47.1 kg. per hectare, or 42.4 pounds per acre, and the non-calcareous soil and subsoil at the rate of 39.1 and 34.4 kg. respectively per hectare, or 35.2 and 31.0 pounds per acre per year.

(3) The third group included eight experiments with four specimens of surface soils and the corresponding subsoils, all calcareous. The experimental periods varied from 163 to 170 days, commencing June 17. In every case there was considerable gain of nitrogen, the gains by the surface soils varying from 40.7 to 46.5 kg. per hectare, or from 36.6 to 41.9 pounds per acre, and by the subsoils from 30.8 to 40.1 kg. per hectare, or from 27.7 to 36.1 pounds per acre per year.

(4) The experiments of the fourth group were made with the same kinds of soil as the third, at the same time, and in the same manner, except that the soil was not moistened, but was thoroughly stirred once a week. It therefore retained only hygroscopic moisture and was quite dry. The gains of nitrogen averaged somewhat larger than in the third group. The most noticeable difference between the results with the two groups was in the quantities of ammonia and nitric acid at the end of the experiments. In the third group the quantities of ammonia changed very little, but that of nitric acid increased and at the end was large. In the fourth group, on the other hand, the quantities of nitric

acid remained nearly constant and the increase of nitrogen was almost wholly in the form of ammonia. In other words, nitrification was active in the moist but not in the dry soils.

Taking the results of all the groups together, there seemed to be rather more gain of nitrogen with calcareous than with non-calcareous soils, but the difference was neither regular nor pronounced. The following are the author's conclusions:

From these investigations it follows that arable soils absorb atmospheric ammonia, whether they are devoid of vegetation, calcareous, acid or neutral, dry or wet. The quantities of nitrogen thus gained are too important to be neglected.

The absorption of ammonia by the soil is dependent upon the difference of tension of the ammonia in air and soil. The absorption, therefore, attains its greatest intensity when the tension in the soil is zero. This condition is realized when the soil is moist and when nitrification causes ammonia to disappear as rapidly as it is absorbed. When the soil is dry nitrification stops, the larger part of the ammonia absorbed retains its form, and increasing in amount effects a tension in the soil. The absorption, therefore, constantly diminishes. Thus moisture in the soil favors the fixation of ammonia, and dryness retards it.

Absorption depends essentially on the renewal of air at the surface of the soil. It is therefore not a matter of indifference whether the surface of a field is free from vegetation or is covered by the residue of crops or by spontaneous vegetation.—[W. O. A.]

Green crops as nitrogenous manures, A. Müntz (*Compt. rend.*, 110 (1890), *p.* 972).—For green manuring leguminous plants are generally selected. Their value for this purpose is due to their power of gathering nitrogen especially from the air. The author considers that their effectiveness when plowed under as green manure will be proportioned to the rapidity with which their nitrogen is changed to nitric acid. To get light upon the subject, he compared the rapidity of nitrification of green lupines with that of dried blood, which is one of the most active nitrogenous fertilizers, and of sulphate of ammonia, which undergoes especially rapid nitrification, in a series of experiments in which each of the substances was added to a light calcareous soil and to a heavy clay soil only slightly calcareous. For each experiment enough of the nitrogenous material was added to furnish one gram of nitrogen for a kg. of soil. The accompanying tabular statement shows the amount of nitric acid formed:

Fertilizing materials supplying 1 gram of nitrogen.	Light calcareous soil.	Heavy clay soil slightly calcareous.
	Milligram.	*Milligram.*
Green lupine	183	86.0
Dried blood	161	3.6
Sulphate of ammonia	288	5.1

It is evident that the heavy soil was unfavorable to nitrification, only 5.1. mg. of nitric acid being formed from the sulphate of ammonia. That so much more was formed from the nitrogen of the lupines is attributed by the author to the loosening of the soil by the decomposing plants, by which aëration was facilitated. In the lighter soil, which was relatively favorable to nitrification, 288 mg. of nitric acid was formed from the sulphate of ammonia. The nitrification of the lupine exceeded that of the dried blood.

Field experiments with maize grown for fodder on land manured with green alfalfa, with dried blood, and with sulphate of ammonia gave results very favorable to the alfalfa.—[W. O. A.]

The decomposition of organic fertilizers in soil, A. Müntz (*Compt. rend.*, 110 (1890), *p.* 1206).—Under ordinary circumstances the nitrogen of all organic substances decaying in soil, changes into nitrates. In 1877 and later Schlösing and Müntz showed that this transformation is due to ferments which they have studied. Of the numerous organisms of soil, the nitro-bacteria are the most important, since it is they that change the nitrogen into nitric acid, the form most assimilable by plants.

In a recent series of experiments, Müntz shows that there are still other organisms which in their work precede those of nitrification. That is to say, these latter transform organic nitrogen into ammonia from which the nitric acid is produced. They are probably indispensable to the life of the nitrifying organisms and to the complete transformation of nitrogenous organic matter. Experiments to decide the question as to whether the nitro-bacteria can live upon other nitrogen compounds besides ammonia, may not prove very difficult, since Winogradsky has succeeded in isolating them in pure cultures. Meanwhile, however, Müntz shows in the present investigation that the agent for the production of ammonia exists in all soils, and that it works the transformation of the nitrogen of organic materials, especially manures, into compounds of ammonia.

There is great difference as to the facility with which the nitrogen of humic compounds and that of other organic substances, such as stable manure and other excreta, dried blood and flesh, horn, wool, leather, oil cakes, etc., is nitrified. Thus the nitrogen of humus is assimilated by plants very slowly, but that of the other substances mentioned, more or less rapidly.

In order to get an insight into the nature of the transformation products of organic nitrogen into ammonia or nitric acid, Müntz experimented with several soils. Some of them were acid and not adapted to nitrification, while others were more or less favorable to the action of nitrifying ferments. Each kind of soil served in three experiments. In one it was used by itself; in a second horn, and in a third dried blood was added. The experiments continued from 11 days to 8 months. In one case the soils were sterilized at 90° C., at which temperature the nitrifying ferment is killed but most of the others are

left intact. When sterilized at 120° C., it was found that generally no ammonia was formed, thus implying that the ammonifying ferment is destroyed. But when soils thus sterilized were inoculated with a particle of fresh soil, the production of ammonia recommenced.

The principal results of the experiment may be recapitulated by saying that in soils in which nitrification could not occur or in which the nitric ferment had been killed, the nitrogen of organic substances was changed to ammonia exclusively. Soils poorly adapted to nitrification had nearly all their nitrogen changed into ammonia and but little to nitric acid; and in arable soils where nitrification was very intense ammonia was not entirely absent.

The author concludes that in all soils special organisms exist which exercise the function of converting the nitrogen of organic matter into ammonia. But there are almost always coexisting organisms which transform the ammonia thus produced into nitric acid. Although the work of the former is only preparatory, yet it is useful and perhaps even indispensable.

In another article (*Compt. rend.*, 111 (1890), *p.* 75) P. Péchard calls attention to his own results which are identical with those of Müntz above referred to, but were published earlier in the account of an investigation on the influence of gypsum and of clay on the retention, nitrification, and fixation of nitrogen (*Compt. rend.*, 109 (1889), *p.* 646). He there showed that in the decomposition of organic matter the formation of ammonia precedes that of nitric acid. This conclusion, he says, was to be expected after the work of Shützenberger on the decomposition of albuminoid substances by the earthy alkalis, especially when Duclaux had shown that their decomposition in the manner named is similar to that produced by the action of microbes.—[W. O. A.]

The decomposition of rocks and the formation of arable soil, A. Müntz (*Compt. rend.*, 110 (1890), *p.* 1370).—In this article the author broaches the very striking theory that either nitro-bacteria or similar microscopic organisms constitute one of the principal agencies in the decomposition of rock and formation of soil, and supports it by a variety of observations. Both igneous and sedimentary rocks undergo constant disintegration. The fine particles either left *in situ* or transported by wind and water during geologic epochs, make the basis of arable soil. The disintegration is caused in part by atmospheric agencies, chemical and physical, and in part by the action of living organisms. It is well known that plants of the higher and lower orders growing on the surfaces or in the fissures of rocks, tend to disintegrate them by the action of acid or other secretions, as well as by mechanical means. According to the observations of the author, microscopic organisms exert a similar but more subtle and far more general action. He has studied the action of these nitrifying ferments upon high mountains, above the limits of ordinary vegetation, as well as in lower regions. As first indicated by the researches of Schlösing and Müntz and explained later by the

investigation of Winogradsky, these ferments are able to assimilate ammonium carbonate, form organic matter from it, and at the same time change part of the nitrogen of the ammonia into nitric acid. The author also believes that they may utilize for their sustenance the very minute traces of alcohol which he has found to be widely distributed and a constant constituent of the atmosphere. All the conditions for their growth would therefore be fulfilled on bare rock and on the highest mountain peaks. Being of microscopic size they are able to penetrate the capillary interstices of rock and the nitric acid which they produce, acting constantly through long periods of time, becomes an effective means of disintegration.

The disintegrated particles are found on examination to be uniformly covered by layers of organic matter, evidently formed by these organisms. This accords with the observation of Winogradsky, that the nitro-bacteria grown in liquids free from organic matter gather about deposits of carbonates and transform ammonia and carbonic acid into organic matter, which thus accumlates in considerables quantities.* The accumulation of the organic matter of the soil thus begun is increased later by the residues of the vegetation of higher orders. By putting specimens of disintegrating rock into sterilized tubes and making bacteria cultures with them, the author showed the presence of nitrifying organisms in the bare rocks of the Alps, Pyrenees, Auvergne, and Vosges. Rocks of the most widely varying mineralogical character —granite, porphyry, gneiss, mica schist, volcanic rock, limestone, and sandstone—were thus shown to be covered with nitro-bacteria. Schlösing and Müntz have shown that these organisms become dormant at low temperature, so that their activity is limited to the summer, especially at high altitudes, but their life does not cease in winter, for he has found them "living and ready to resume their activity after a sleep of ages under the enduring ice of glaciers, where the temperature does not rise above zero."

But while the organisms are so abundant on the bare rocks of high mountains where the conditions for their action are most simple, their nitrifying activity is exercised on a far vaster scale under the normal conditions existing at lower levels, where the rock is covered with vegetable soil. They act upon minute fragments, and thus reduce them to smaller and smaller size; nor are they limited to the surface, but they penetrate into the interior of the rock mass. This is the case with the rock material known as "rotten rock," the particles of which become separated, as often happens in limestone, schists, and granite. "In such decomposing rocks," says the author, "I have always established the presence of the nitrifying organism." One of the most striking examples of this is furnished by the mountain in Switzerland called in German Faulhorn, in French Pic Pourri ("Rotten Peak"), which consists of a

* See Experiment Station Record, vol. II, p. 754.

calcareous schist, friable, and in process of disintegration. Its whole mass is invaded by the nitric ferment.

"When we consider the feeble intensity of these phenomena we are tempted to underestimate their importance, but being so general and continuous they really deserve to be classed among the geologic causes to which the crust of the earth owes its actual physiognomy, and which especially have contributed to the deposits of fine material which constitute arable soil."

In the view thus presented by Müntz, nitro-bacteria, the existence of which was first indicated by Schlösing and himself in 1877, and which were first isolated and definitely studied by Winogradsky a little over a year ago, are of the highest interest to the geologist as one of the dynamic agencies which decide the topography of the earth's surface; and to the farmer as the means by which the nitrogen compounds of the soil are changed into the nitrates upon which his crops feed, and even the soil itself is formed.—[W. O. A.]

Microbes and root tubercles in relation to the fixation of free nitrogen by peas, Schlösing, jr., and Laurent (*Compt. rend.*, 111 (1890), *p.* 750).—Experiments by the authors are reported, which confirm the fixation of free nitrogen by peas and the connection of microbes and root tubercles with the process. While previous experiments had been made by what they designate the "indirect method" of comparing the nitrogen in the seed and soil at the beginning of the experiment with the amount found in the plant and soil at the end of the experiment, and taking the difference as the measure of the quantity of nitrogen acquired from the air, these experimenters employed the "direct method," growing plants in sand inside an apparatus containing a definite volume of air, the nitrogen in which was estimated at the beginning and at the end of the experiment, and taking the loss as the measure of the amount fixed by the plant. The apparatus was also utilized in experiments where the nitrogen gained was estimated by the "indirect method," explained above. In two experiments the apparatus and sand were sterilized, peas planted, and their inoculation provided for by the addition of crushed root tubercles. The peas grew during 3 months. The plants were small, apparently healthy, and produced flowers, but no fruit. At the end of the experiment the roots had abundant tubercles. By the direct method it was estimated that the plants in the first experiment acquired 36.5 and those in the second experiment 32.5 mg. of nitrogen. By the indirect method the quantities of nitrogen fixed were estimated at 40.6 and 34.1 mg. respectively. The difference in results by the two methods is attributed to unavoidable errors in analysis. Still another experiment was made, but without determination of gaseous nitrogen and without inoculation. The plants had no root tubercles and showed by the indirect method no considerable gain of nitrogen. The inference is that the peas which were inoculated by the bacteria and had root tubercles, fixed gaseous nitrogen.—[W. O. A.]

Contributions to the knowledge of the nitrogenous compounds of arable soil, Berthelot and André (*Compt. rend.*, 112 (1891), *p.* 189).—In previous investigations* the authors have studied the formation of ammonia in ordinary cultivated soil free from considerable quantities of vegetable mold. Such soils contain extremely little ready-formed ammonia or ammonium salts, their nitrogen being largely in the form of amide-like compounds which yield ammonia gradually by treatment with acids or dilute alkalis, cold or hot, and even by treatment with water at ordinary temperature. These amides are the source of the ammonia ordinarily found in the analysis of soil. The same gradual decomposition by water and by alkaline and earthy carbonates gives rise to the ammonia which is emitted by cultivated soils and diffused through the atmosphere. The amide substances which are thus decomposed may be divided into three classes: (1) Amides proper, which are formed by the union of acids with ammonia and from which ammonia is more or less readily evolved by the action of acids and alkalis; (2) alkalamides which are formed by the union of volatile nitrogenous bases with acids, comport themselves similarly to the amides, and yield volatile nitrogenous compounds; (3) alkalamides which are formed by the union of non-volatile nitrogenous bases or allied bodies with acids, and in being decomposed yield non-volatile nitrogenous products. Of these alkalamides, some are soluble in water, others are insoluble. The soluble ones when broken up by acids or alkalis may yield products, acid or alkaline, which are soluble, or those which are insoluble in water. Similar distinctions apply to the nitrogenous organic compounds of ordinary cultivated soil. A knowledge of them is indispensable for the interpretation of the analysis of the soil and the understanding of its constitution; nor can it be doubted that they are important factors in the absorption of nitrogenous and carbonaceous compounds of the soil by the plant, and in vegetable nutrition generally.

In the study of a clay soil, it was found that the ratio of the organic carbon to the nitrogen was such as would correspond to one part of albuminoid material with three parts of humic or allied compounds, such as are derived from carbohydrates. It is to be expected that the researches of Schützenberger on the constitution of proteids may throw light upon that of the nitrogenous compounds of the soil.

The authors have studied the changes produced in the nitrogenous compounds of soil by the action of acids and alkalis of different degrees of concentration, at different temperatures, and during different intervals of time. They determined in each case the amounts of nitrogen (1) disengaged as ammonia or other volatile alkaline compounds; (2) remaining in non-volatile compounds soluble in water; and (3) remaining in insoluble compounds. In a number of cases they also determined the amount of carbon in each of these compounds. With a cold

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* Ann. Chim. et Phys., 6 ser., 11 (1887), p. 289.

concentrated solution of potash, nitrogen was eliminated in the form of ammonia or other volatile alkaline compounds, at first very rapidly, then slowly, and afterwards very slowly and in amounts proportioned to the time of the action. It was concluded that there were in the soil two distinct amide-like compounds, differing in the facility with which they are transformed into ammonia. Besides the nitrogenous material transformed into ammonia, a much larger portion was rendered soluble in water, but a part of this latter gradually reverted to an insoluble form. The residue of the soil after extraction by potash, on treatment with dilute acid, yielded still more ammonia and amide-like compounds. Over nine tenths was thus rendered soluble by either acid or alkali or both. The tendency of the action of both acid and alkali was to decompose the nitrogenous compounds and to form products of lower molecular weight.

In conclusion, the authors add that these experiments show how the insoluble nitrogen of humus compounds is gradually rendered soluble and assimilable. While the action of the plant upon these compounds in the soil is certainly not identical with that of the acids and alkalis of the laboratory experiments, nevertheless the latter offer certain grounds of comparison in the consideration of the chemical processes induced by earthy carbonates and by carbonic acids, as well as by the acids formed by the plants. The length of duration of these natural processes makes up for the slowness as compared with the more energetic action of the mineral acids and alkalis. That is to say, the comparatively weak bases and acids which occur in the soil and are elaborated by plants, tend to set free the nitrogen of humus, both that of the vegetable matter of which it is formed and that of the ammonia which it absorbs from the air. It may be assumed that alkaline and acid fertilizers, such as lime, ashes, and acid phosphates, serve a similar purpose in rendering the nitrogen of the soil available to plants.—[W. O. A.]

The volatile nitrogenous compounds exhaled by arable soil, Berthelot (*Compt. rend.*, 112 (1891), *p.* 195).—In continuation of previous investigations the author made experiments with argillaceous sands, or clays poor in nitrogen. These were placed in porcelain pots, under bell glasses of 50 litres capacity. Arrangements were provided for introducing water to moisten the soils and collecting the water which condensed on the bell glass. A dish containing dilute sulphuric acid was also placed under the bell glass to absorb the ammonia emitted from the soil. The experiments continued from May to October, 5½ months. During the first half of this time the soil was moistened occasionally. The moisture which collected on the bell glass was removed weekly and sulphuric acid was added to it to hold the ammonia. During the remainder of the time of the experiment the soil was not moistened; it became dry and the moisture ceased to condense on the

bell glass. At the end of the experiment determinations were made of (1) the ammonia absorbed by the dilute sulphuric acid; (2) the ammonia taken up by the water of condensation and expelled by distilling with magnesia; (3) the organic nitrogen remaining after treatment with magnesia. Other experiments were made in the same way, except that sundry non-nitrogenous organic matters, such as mannite, starch, and humus derived from sugar, were added to the soil, but without essential difference in result. While the soils were kept moist, a not inconsiderable amount of ammonia and a still larger quantity of organic nitrogen compounds were given off. The total nitrogen volatilized in these forms and collected in the acid and water was 2 mg. from 1 kg. of soil in 2½ months. During the time that the soil was not moistened, only minute quantities were exhaled. In these cases also the proportion of organic nitrogen was several times larger than that in the form of ammonia.

The most interesting result was that the nitrogen given off under these conditions by argillaceous sand in the form of volatile organic compounds, was invariably larger in amount than that given off as ammonia. In the previous experiments referred to, cultivated soil twenty times richer in nitrogen than the argillaceous sand of these experiments like wise gave off two kinds of compounds, but the ammoniacal nitrogen exceeded the organic in amount. This was the case both with soil destitute of vegetation and with plants of a higher order. The author infers that these phenomena are always brought about by the influence of microbes or of plants of a low order, which are contained in all soils and which manufacture the small quantities of volatile organic nitrogenous compounds observed. These latter he speaks of as a kind of vegetable ptomaines.—[W. O. A.]

Researches on humus substances, Berthelot and André (*Compt. rend.*, 112 (1891), *p.* 916).—Our cultivated soils are formed by the union of various minerals with brown organic compounds. The latter, classified as humus, play an important rôle in the fertility of soil and in the nutrition of the plant, but their function has been established by practical observers rather than defined and analyzed by scientific research, and still remains one of the great unsolved problems of agriculture.

Not only do these compounds or the products of their transformation play an essential rôle in the nutrition of plants and especially in the circulation of nitrogenous products, but they also contribute to the power of the soil to hold in reserve certain mineral compounds despite the dissolving action of water, a faculty which is also possessed by basic silicates and is inaptly designated as absorptive power. Great as is the agricultural interest attaching to these humus compounds, chemists appear to have been repelled from their study by their instability, their insolubility, and their non-crystalline nature. It is hardly possible in the present state of our knowledge to represent them by

the constitutional formulas usual in organic chemistry. Nevertheless they present problems of great interest from the standpoint of chemistry and vegetable physiology because of the phenomena of hydration and dehydration, molecular condensation, and of transformation of colloidal substances which they manifest.

After devoting some time to the study of nitrogenous humus compounds which occur in the soil and are complex and of uncertain origin, it seemed advisable to the authors to devote their attention to those formed artificially in accordance with well-defined principles, and containing only carbon, hydrogen, and oxygen. For this purpose they used the product of the action of hydrochloric acid on cane sugar, which is known as ulmin and ulmic acid, and which in their view should be regarded as a condensed anhydride or a mixture of several anhydrides derived from certain acids which result from the metamorphosis of sugar. Treated with alkaline solutions, this anhydride swells up in the manner of colloid substances and forms salts of different degrees of basicity, some of which are soluble and some insoluble. The insoluble basic potassium salts are of special interest. These have escaped the attention of previous observers, having been mistaken for other substances. Such is their insolubility that the anhydrate formed from sugar, just referred to, is able to remove nearly the whole of the potash or soda from a solution in water by forming the insoluble basic salts. It is also able to decompose small quantities of potassium chloride setting hydrochloric acid free. Its behavior with sodium, barium, calcium, and also with ammonium is similar to that with potassium. The authors devoted their special attention to the insoluble potassium salt, because of its especial interest in explaining the absorptive powers of humic compounds. The salt resists the solvent action of water to a very marked degree. Even when boiled with 120 times its weight of water for an hour it was but slightly decomposed, and was but little acted upon by carbonic acid in the cold. From a solution of potash in 120 times its weight of water, the anhydride takes the amount required to form the insoluble salt just described, and by this means nearly all the potash can be removed from even a very dilute solution. Other salts of potassium, sodium, barium and ammonium were studied. Ammonia forms with the anhydride amido acid salts.

These researches throw a new light on the function of humus compounds in the soil, by indicating that they combine with both ammonia and the mineral alkalis, protect them from the leaching action of the water which circulates through the soil, and hold them in reserve for the use of the plants. In other words, the absorptive power of the soil which has been currently attributed to hydrous silicates, is shared also by the humus compounds.—[W. O. A.]

Gain or loss of nitrogen by soils, A. Pagnoul (*Ann. Agron.*, XVI (1890), 6, *p.* 250).—To test the gain or loss of nitrogen in a soil with and without crops growing upon it, trials were made with soil in glazed

earthenware pots provided with arrangements for aëration and the collection of drainage water. In each pot were placed 22 kg. of soil containing 22.44 grams of nitrogen, to which were added dried blood containing 0.54 gram of nitrogen, and sulphate of ammonia containing 1 gram of nitrogen, making altogether 23.98 grams of nitrogen. Calcium sulphate and natural phosphate were also added. The pots were divided into three lots of two each, designated A, *a*; B, *b*; C, *c*. The experiment continued two years, from March, 1888, to March, 1890. Grass was sown and harvested each season in B and *b* and red clover in C and *c*. In pots A and *a* no plants were allowed to grow. Determinations were made of nitrogen as ammonia and nitric acid in the drainage waters of each season; and of the nitrogen in the soil and fertilizers at the beginning of the experiment in the crop of each season, and in the soil at the end of the experiment. The results so far as the gain of nitrogen by the soils is concerned, are recapitulated in the table herewith, in which averages of duplicate trials are given. The nitrogen gained of course came from the air.

Nitrogen statistics.

Nitrogen—	Without plants, average of A and *a*.	With grass, average of B and *b*.	With clover, average of C and *c*.
	Grams.	*Grams.*	*Grams.*
Remaining in soil at end of experiment*	24.20	26.95	30.80
Removed by crops of two seasons	....	1.47	4.20
Removed in drainage water of two seasons	0.87	0.08	0.20
Total	25.07	28.50	35.20
Amount in soil at beginning of experiment	23.98	23.98	23.98
Gross gain by soil and crops	1.09	4.52	11.22
Loss in drainage	0.87	0.08	0.20
Net gain by soil and crops	0.22	4.44	11.02
Removed in crops	....	1.47	4.20
Net gain by soil	0.22	2.97	6.82

* Including nitrogen of roots of plants.

The surface area of the soil in each pot was 7.54 square dm. Estimated per hectare, the net gain of nitrogen by the soil after the removal of the crops would be, without plants 29 kg., with grass 394 kg., and with clover 904 kg.; or per acre without plants 26.1 pounds, with grass 354.6 pounds, and with clover 813.6 pounds.

As results of this investigation it appears that, (1) the loss of ammonia by drainage was inconsiderable in the soil either with or without plants; (2) the loss of nitric acid was quite large, especially in the soil without vegetation (taking the loss of nitric acid in the experiment with grass as 1, with clover it was 3, and without plants 17); (3) in the second year the soil without plants lost less nitric acid, and the soils with crops more than in the first year; (4) the crops of the second year were smaller than those of the first year, notwithstanding the greater apparent nitrification and the gain in nitrogen.—[W. O. A.]

Citric acid as a normal constituent of cows' milk, T. Henkel (*Landw. Vers. Stat.*, 39, *pp.* 143–151).—The author prefaces the report of his investigations with a brief summary of the substances besides albuminoid materials, fat, milk sugar, and ash, which, according to present views, occur in small quantities in normal milk. Of nitrogenous bodies other than the albuminoids, he mentions urea, ammonia, hypoxanthin, and lecithin. The old theory that peptones are contained in milk, is believed to have been disproved by more recent investigations.* Among the nitrogen-free materials of the milk he recognizes cholesterin.

Regarding the organic acids of milk, Soxhlet† first remarked that the amount of lime contained in solution in milk seemed to be opposed to the fact that milk contains phosphoric acid in solution. He suggested the presence of an "organic phosphoric acid" whose neutral calcium salt was soluble. Söldner ‡ in his work on the salts of the milk, further advocated the presence of organic acids in milk. According to Heidlen,§ lactic acid is not a constituent of fresh milk, and only occurs in milk which has stood. The author states that the only previous mention of the actual finding of an organic acid in fresh milk is by Duval,‖ who stated that he found the salt of such an acid in mares' milk. This salt, as described, crystallized in groups of small needles, was not volatile, gave a peculiar odor on heating, and differed from hippuric acid in its relation to silver nitrate and iron chloride. He named this acid *acide equinique.*

The present investigations were made by the author under the supervision of Professor Soxhlet, at the Central Experiment Station in Munich. It seemed probable from all previous investigations that the organic acids if present must be contained in the milk serum in the form of soluble salts. A serum was prepared from separator skim milk by removing the casein, first with a strong rennet solution and then with acetic acid and Spanish clarifying earth (*Klärerde*), and neutralizing with milk of lime to the point of acidity of normal milk serum (100 c. c. = 3. 2 c. c. fourth-normal soda solution). By this means a clear milk serum of normal acidity was obtained. On evaporation of the serum a precipitate separated out, which was found by qualitative tests to be the calcium salt of an organic acid, containing also a small admixture of calcium phosphate. This organic acid was obtained free (1) by decomposing the calcium salt with oxalic acid, and (2) by preparing the lead salt and decomposing it with hydrogen sulphide. When purified and concentrated both these solutions gave a crystalline mass. Larger quantities of the pure acid were prepared by decomposing the calcium salt with H_2SO_4, dehydrating with anhydrous gypsum, placing over

* Jahresber. f. Thier Chem., 6.13; Zeitsch. f. physiol. Chem., 2, 28; *ibid.* 9, 591.
† Jour. f. prak. Chem., 6, 1.
‡ Landw. Vers. Stat., 35, 354.
§ Ann. d. Chem. u. Physik., 45, 263.
‖ Compt. rend., 82, 419.

H_2SO_4, and finally extracting with ether. One hundred grams of water-free crystals of the acid were obtained in this manner. This acid agreed with pure citric acid in (1) elementary composition; (2) the ability to form a saturated sodium salt giving no acid reaction with phenolphthalein; (3) water of crystallization of the calcium salt and the behavior of this when the salt was dried over H_2SO_4, or at 100° C.; (4) the calcium content of the saturated (tri) and unsaturated (di) calcic salt; (5) melting point; (6) solubility in ordinary solvents; and (7) giving the Sabanin-Laskowski reaction, which is peculiar to citric and aconitic acids only.

Experiments were next made to determine whether the citric acid was actually contained in the milk, or whether it was possibly formed during the process of preparation from a decomposition of the constituents of the milk, either by the rennet or by the continued evaporation of the serum. Serum prepared from fresh cows' milk without the use of rennet, (1) by means of HCl, etc., and (2) by filtering the milk through cells of unglazed earthenware and heating, yielded in both cases an organic acid with the characteristics given above. Samples of serum prepared in each of the three ways (with and without rennet) were rapidly evaporated in a vacuum at 40° C.; all yielded the same amount of calcium citrate found in previous trials. These results showed conclusively that the citric acid found was not a product of the decomposition of the milk constituents by the rennet or by the continued heating of the serum. It must therefore be a constituent of the milk used in the investigations.

Finally, 30 samples of milk from different herds of cows receiving different rations, and the mixed milk from creameries, were examined with reference to their citric-acid content. The amount of calcium salt found (containing only a trace of calcic phosphate) varied from 1.5 to 2.1 grams, equivalent to from 1 to 1.4 grams of citric acid per liter of milk. Numerous examinations made of the concretions and sediment forming in sterilized and unsterilized condensed milk, showed these materials to consist to considerable extent of calcium citrate.

The results of these investigations lead the author to conclude that citric acid is regularly present and a normal ingredient of cows' milk.

Concerning the origin of citric acid in milk, A. Scheibe (*Landw. Vers. Stat.*, 39, *pp.* 153–170).—This investigation, like the preceding, was made in the laboratory of the Central Experiment Station at Munich, under the supervision of Professor Soxhlet. The questions proposed by the author were: (1) Is citric acid contained in other than cows' milk? and (2) From what source does the citric acid in milk come? In a preliminary report on the investigations of Henkel, Professor Soxhlet stated that no citric acid had been found in human milk, and he suggested that its presence in the milk of herbivora might perhaps be accounted for in two ways: (1) Citric acid being a constituent of vegetable foods, as hay, roots, etc., may pass from the food into the milk;

(2) being a product of the decomposition of cellulose, it may possibly be formed, together with other organic acids and gases, in the process of fermentation of the cellulose in the alimentary canal. According to either proposition the presence of citric acid would be traceable directly or indirectly to the food. Although the weight of evidence seems to be to the effect that citric acid when taken into the organism is rapidly burned to carbonic acid and water, it is suggested that a transfer of citric acid from the food to the milk is still conceivable, since in the secretion of milk not the final products of decomposition but probably the substance of the body itself is drawn upon. Carbohydrates are also completely burned within the body, but milk-producing animals separate a carbohydrate (milk sugar) in large quantities in the milk.

The author proceeded to make exact determinations of the amount of citric acid in milk, according to a quantitative method devised by himself, which is described in detail. This method depends upon setting free the citric acid in the prepared milk serum with 2½ normal sulphuric acid, dissolving the freed acid in alcoholic ether, separating the milk sugar by crystallization, and finally precipitating the citric acid (together with the sulphuric and phosphoric acids) with alcoholic ammonia. The citric acid is determined in the final precipitate by decomposing the ammonium citrate with a solution of bichromate of potash, and measuring the carbonic acid evolved. The amount of citric acid found in cows' milk by this method was 1.7 to 2 grams per liter—a somewhat larger amount than Henkel found.

With this exact method the author separated citric acid from human milk also, the amount found being 0.54 grams per liter of milk, or less than a third of that in cows' milk.

After the presence of citric acid in goats' milk had been recognized, feeding experiments were undertaken with goats to study the influence of different rations on the citric acid content of the milk. In different periods rations were fed consisting respectively of (1) ordinary hay, (2) brewers' grains, (3) beets and hay, (4) beets, oat straw, and linseed cake, (5) clover hay, (6) black bread, (7) black bread, white bread, and wheat flour alternately, (8) hay and increasing amounts of citric acid partially neutralized with sodium hydrate, and (9) pea soup. The latter ration, however, was only digested to a slight extent and was not eaten readily, so that this period was partially a hunger period. The results of these feeding experiments lead the author to conclude that—

(1) The citric-acid content of goats' milk is practically the same as that of cows' milk, amounting with ordinary feeding to from 1 to 1.5 grams per liter. The variations from day to day on the same food were not inconsiderable, and the percentage of citric acid in the solids varied even more widely.

(2) The citric acid in milk is not derived from citric or other organic acids contained in the fodder (hay, roots, etc.), for (*a*) it is contained in human milk, although in smaller amount; (*b*) the feeding of increasing

quantities of citric acid, amounting in some cases to forty times the amount given off in the milk, was accompanied by no increase of citric acid in the milk produced; (*c*) during the feeding of bread, wheat flour, and pea meal, "which surely contained no citric acid," the milk continued to show the normal amount of this acid; and (*d*) when the animals were fasting or when only a very limited quantity of food was eaten, there was no decrease noticed in the citric-acid content.

(3) Citric acid does not come from the products of the fermentation of cellulose in the alimentary canal of herbivora, for human milk contains citric acid, and when bread, wheat flour, or pea meal were fed, and during fasting, the critic-acid content remained normal.

The presence of citric acid in the milk given by fasting goats, is analogous to the presence of milk sugar in the milk of carnivora receiving food free from carbohydrates, and of fasting herbivora. When the origin of milk sugar shall have been clearly shown, it may be possible to secure some light as to the formation of citric acid from the other constituents of the food or from the animal substance itself.

Although these investigations furnish no definite answer to the question as to the origin of the citric acid of milk, the author believes they indicate that citric acid is a specific milk constituent, which, like the casein, the glycerides of the volatile fatty acids in the butter fat, and the milk sugar, is a product of the lacteal glands; but from what constituents of the food or the body these ingredients, especially milk sugar, are formed, it is at present impossible to say with certainty.

Volatile fatty acids in Holland butter, **A. J. Swaving** (*Landw. Vers. Stat.*, 39, *pp.* 127-141).—The author first briefly notices some of the previous investigations made with a view to determining the influence of food, period of lactation, etc., on the volatile fatty acids of butter.

Thus, he states that in 1882 Munier* examined samples of butter from the vicinity of Amsterdam, during the whole year, and found that the percentage of volatile fatty acids was lowest during the months of October, November, December, and January.

In 1888 Coster, Van Hoorn and Mazure† examined butter made by themselves each month of the year from the milk of a large number of cows. They conclude from these studies that in the critical examination of butters the season of the year in which they were made should be considered.

The investigations of Cornwall and Wallace,‡ in which examinations were made of the butter produced by individual cows during a year, showed no constant relation between the volatile fatty acids and the season, breed, age of animal, feeding, or time since calving. They give as the average of 80 samples of butter, 13.68 c. c. of tenth-normal alkali for 2.5 grams of melted butter fat.

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* Zeitsch. f. analyt. Chem., 82, p. 397.

† S. verslag van den toestand der gemeente Amsterdam gedurende het jaar 1888.

‡ Zeitsch. f. analyt. Chem., 1887, p. 317.

Besana* examined 114 samples of butter from December, 1887, to April, 1888, which came from 30 different Italian provinces and represented 96 different dairies. The results ranged from 21.8 to 30.19 c. c. tenth-normal alkali for 5 grams butter fat (Reichert-Meissl-Wollny method).

Nilson† made experiments extending over one year with 15 cows all of the same breed, which were fed rye, beets, and hay. The volatile acids ranged from 9.27 to 20.5 c. c. tenth-normal alkali per 2.5 grams of butter fat (Reichert figures). Nilson claims that the content of easily melted glycerides and the qualities of the butter fat accompanying this are not dependent on the feeding, but that the differences between summer and winter butter are due rather to the fact that at the time when cows are feeding on pasturage and green fodders they are more likely to be in the first stages of the milking period.

In opposition to this belief are the investigations of Adolf Mayer,‡ which indicated that not only the lactation period, but also beyond doubt the food had a marked influence on the volatile acids of the butter. Spallanzani§ came to the same conclusion from his studies of butters from different sections of Italy.

The author's original plan was to have samples of butter sent him every 2 weeks from reliable sources in each province of Holland, accompanied by statements regarding the number, age, time since calving, and breed of the cows from which the butter was made, and the food they received. He hoped in this manner to secure data which would enable him, with due reference to period of lactation and food, to fix limits to the volatile fatty acids which would be of service in the critical examination of the butter.

Although the original plan was not carried out in all its details, the investigations were quite extensive and are a valuable contribution to the knowledge regarding Holland butter.

The author's conclusions are as follows: (1) The formation of volatile fatty acids in the butter is dependent upon both the period of lactation and the food. (2) With the beginning of a new period of lactation the content of volatile acids increases, and as the period advances these acids diminish in quantity. With the beginning of the pasturage season these acids increase, or at least are quite high; as the season advances they decrease in amount. (3) On account of the prevailing differences in the time at which the new period of lactation begins, and of the influence of food on the amount of volatile fatty acids, it becomes impossible to fix the limits of these acids either for the different districts or for the different months of the year. (4) For the

* Sui methodi atti a distinguere il burro artificiale dal burro naturale et le loco mis cele. 1888.

† Zeitsch. f. analyt. Chem., 1889, p. 179.

‡ Landw. Vers. Stat., 34 (1888), p. 261.

§ Contributo allo studio degli acidi grassi volatili di Burro.

critical examination of butter the minimum limit of volatile fatty acids may be taken as that content requiring 19 c. c. of tenth-normal alkali per 5 grams of butter fat, according to the Reichert-Meissl-Wollny method.

Ontario Agricultural College and Experimental Farm, Sixteenth Annual Report, 1890 (pp. 262).—This report includes statistics relating to the college and experimental farm, reprints of bulletins, accounts of experimental inquiries not published elsewhere, and a report of the eleventh annual meeting of the Ontario Agricultural and Experimental Union. The following statements are taken from those portions of the report which relate to the experimental work of the institution:

Bulletin No. 52.—Black knot on plums, J. H. Panton (pp. 39, 40).—A popular account of the life history of the fungus causing black knot on plums (*Plowrightia morbosa*), with suggestions as to remedies.

Bulletin No. 56.—Smut of grain, J. H. Panton (pp. 40–45).—Brief accounts of stinking smut (*Tilletia foetens*), loose smut (*Ustilago segetum*) and corn smut (*Ustilago zeæ mays*), with suggestions as to remedies.

Meteorological observations, J. H. Panton.—A tabulated monthly summary of observations at the college during 1890.

Corn for fodder and silage, C. C. James (pp. 47–62).—Tabulated analyses of the ears, stalks, and leaves of a number of varieties of dent, flint, sweet, and silage corn, with extracts from the reports of investigations on corn issued by stations in the United States.

Analyses of fish, C. C. James (pp. 63–66).—A tabulated record of analyses of the head and entrails of salmon, finely divided refuse from a canning factory, and whole herrings, with comments on the value of such materials as fertilizers.

Sugar beets, C. C. James and W. Skaife (pp. 66–75).—A tabulated record of analyses of sugar beets grown at the college and elsewhere in Ontario in 1890. The following is a general summary for the province:

	Number of samples	Average weight.	Solids.	Sugar.	Purity.
		Lbs. oz.	*Per cent.*	*Per cent.*	*Per cent.*
78 beets, over 2 pounds each in weight	35	2 14	16.45	12.35	75.1
341 beets, under 2 pounds each in weight	82	0 14	17.41	14.10	81.02
Average of 419 beets	117	1 4	17.12	13.58	79.32

The 1889 samples analyzed at the chemical laboratory, Guelph (26 in number), showed an average weight of 2 pounds 2 ounces, solids 18.95 per cent, sugar in juice 14.35 per cent, and purity 75.7 per cent, from which it will be seen that the beets of 1890 were smaller, slightly lower in sugar, but higher in purity, and represent a class of beets much more profitable for sugar making than those of 1889. The difference in value between large and small beets is clearly brought out in the above general summary, the smaller beets being the richer and of higher purity.

A brief account of the cultivation of the crop of sugar beets on the experimental farm is given in another part of the report (pp. 96–98).

Observations with the rain gauge, lysimeters, and soil and air thermometers, C. A. Zavitz (pp. 76, 77).—Tabulated summaries for the months from May to September, inclusive.

Field experiments, T. Shaw and C. A. Zavitz (pp. 100–114, 154–186, and 244–253).—These included tests of varieties and different dates of seeding of barley, spring and winter wheat, and oats; tests of varieties of peas, potatoes, turnips, mangel-wurzels, and carrots; experiments in the cultivation and manuring of rape; tests of grasses for pastures, singly and in mixtures; and coöperative experiments with fertilizers on oats, and in the cultivation of corn.

Barley, spring wheat, oats, and peas.—A summary of the experiments with these kinds of grain is reprinted from Bulletin No. 58 of the Ontario Station (see Experiment Station Record, vol. II, p. 675). The detailed tabulated record includes data for 54 varieties of barley, 54 of spring wheat, 92 of oats, and 20 of peas. In the experiments in sowing grain at three different dates (May 1, 9, and 17), the best results were obtained from the earliest sowing.

Winter wheat.—Tabulated data are given for 18 varieties from Ontario seed and 19 from seed from Germany, Russia, England, and France A summary is reprinted from Bulletin No. 53 of the Ontario Station. Of the Canadian varieties, Red Velvet Chaff, Lancaster, Martin Amber, and Volunteer gave the best results; of the foreign varieties, Galezien Summer, White Square Head, Russian Odessa, and Lamed Hybrid.

Potatoes, turnips, mangel-wurzels, and carrots.—Tabulated data are given for 28 varieties of potatoes, 48 of turnips, 29 of mangel-wurzels and 11 of carrots.

Experiments with rape.—Experiments are reported with rape grown on plats of loam, marl, clay, and muck soils, to which salt had been applied at the rate of 400 pounds per acre, on barley in 1888, and on oats in 1889, as compared with rape grown on similar plats to which no salt had been applied. In every case the yield was larger on the plats fertilized with salt. The largest yield was on loam soil and the smallest on the clay. In another experiment, in which nitrate of soda, dried blood and scrap, salt, superphosphate, and unleached wood ashes were used singly and compared with no manure, nitrate of soda produced the largest increase in yield. Level culture gave better results than drilling in both 1889 and 1890. In an experiment in which 4 pounds of seed per acre were sown in drills and the plants on some of the plats were thinned to 15 inches apart, the thinning very materially reduced the yield.

Pasture grasses.—The results of an 8 years' test of 15 species of grasses grown singly on twentieth-acre plats, are briefly reported in a table. The most enduring varieties are stated to be meadow foxtail, wood meadow grass, rough-stalked meadow grass, various-leafed fescue, sheep's fescue, hard fescue, and red fescue. The mixtures of grass found to be most reliable in this locality are meadow foxtail, orchard

grass, and Kentucky blue grass, and meadow fescue, tall oat grass, and wood meadow grass.

Coöperative experiments.—Abridged reports are given of coöperative field experiments with fertilizers for oats, and on different modes of cultivating corn.

In the experiments with fertilizers for oats, superphosphate 400 pounds, dried blood and scrap 400 pounds, and barnyard manure 14 tons per acre, were each applied to 1 fortieth-acre plat; a fourth plat received no fertilizer. The average yield with each fertilizer is tabulated. The fertilized plats all gave an increased yield over the unfertilized plat, but the increase was nearly the same with each fertilizer, except that barnyard manure gave about 300 pounds more straw per acre than either of the other two.

Each experiment with corn was made on 4 tenth-acre plats. The corn, presumably for fodder, was planted on two plats in drills 3½ feet apart, with the kernels dropped in one case 2 and in the other 12 to the foot; and on the other two plats it was broadcasted at the rate of one half and 3 bushels per acre respectively. According to the average yield per acre, the largest yield occurred where the corn was broadcasted at the rate of 3 bushels per acre, and the next largest where it was sown in drills with 2 kernels to the foot.

Live stock experiments, *C. A. Zavitz* (pp. 186–201).—*Corn silage as a food for making beef.*—In this experiment three lots of grade steers, two steers in each lot, were fed from December 31 to April 29, the following rations daily:

Lot I. 12 pounds meal and silage *ad libitum.*
Lot II. 12 pounds meal, 45 pounds silage, and hay *ad libitum.*
Lot III. 12 pounds meal, 45 pounds turnips, and hay *ad libitum.*

The meal consisted of equal parts by weight of peas, barley, and oats.

The gains in live weight during the 119 days are tabulated as follows: Lot I: No. 1, 247 pounds; No. 2, 193 pounds. Lot II: No. 3, 222 pounds; No. 4, 220 pounds. Lot III: No. 5, 219 pounds; No. 6, 185 pounds.

The pecuniary results are not calculated.

Fattening lambs.—Forty-eight lambs, nearly all Cotswold and Oxford-Down grades were pastured in a field of rape from October 10 to December 10, and fed in a shed from December 10 to February 10 on sliced turnips, whole oats, and hay. One of the lambs died during the experiment. The lambs gained 864 pounds in live weight in the 2 months while at pasture and 544 pounds while fed in the shed. The lambs were sold for 5¾ cents per pound, realizing $185.60 over the first cost of the lambs October 10.

Corn silage and roots as food factors in swine feeding.—An experiment was made with pigs averaging 204.5 pounds each to test the value of corn silage and turnips. Three lots each containing a barrow and one

small and one large sow, were fed from January 10 to March 28 as follows:

Lot I received daily 16½ pounds of a mixture of one part each of wheat middlings and ground oats and three parts of pea meal; Lot II, 5½ pounds of the same mixture and 60 pounds sliced turnips; and Lot III, 5½ pounds of the mixture and 35 pounds of corn silage in place of the turnips. The 3 pigs in Lot I gained 270.5 pounds, those in Lot II 139.5 pounds, and those in Lot III 80.5 pounds live weight during the experiment.

Feeding swine on grain and meal.—To test the comparative feeding value for young pigs of (1) a mixture of 2 parts of ground peas and 1 part each of ground oats, ground barley, and wheat middlings; (2) a mixture of equal parts of peas and barley, ground; and (3) the same unground. These rations were each fed to one lot of pigs containing one full-bred and three grade Berkshires, averaging about 50 pounds each, from January 17 to May 31. The general health of the pigs receiving ration 1 was better than that of those on the other rations. Some of the latter became "stiffened" after a time, and in one case a change to lighter food was necessary.

The average amount of food eaten and the average gain in live weight per day are given for the pigs on each ration as follows:

Average per animal, daily.

Rations.	Food consumed.	Gain in live weight.
	Pounds.	*Pounds.*
I. Ground peas (2 parts), ground oats and barley, and wheat middlings	3.07	1.35
II. Ground peas and barley	2.27	0.49
III. Whole peas and barley	2.36	0.21

Mixture No. 1 seems to have produced the best gains in live weight. The financial advantages of the several rations are not considered.

Green fodder as a food for swine.—Three lots of Berkshire pigs were fed from June 7 to October 8 the following rations respectively, the object being to test the value of green fodders (clover, oats, millet, and fodder corn at different times) as a substitute for part of the grain:

Lot I was given a grain mixture consisting of two parts of peas and one part each of barley, oats, and wheat middlings, *ad libitum.* In the case of Lot II, about one fourth and of Lot III, about two thirds of the grain mixture was replaced by green fodder. The results follow:

Food eaten and gains in live weight.

	Food consumed per animal daily.		Gain in live weight during experiment.		
	Grain.	Green fodder.	Pig 1.	Pig 2.	Pig 3.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Lot I	4.12		105	92	95
Lot II	3.09	1.85	43	79	100
Lot III	1.39	3.77	7	27	25

While the gain in live weight varies widely with the different pigs in Lots II and III, it is evident that the best results were secured where the full grain ration was fed, and the pigs in this lot (I) were in the best condition at the close of the experiment.

Soiling cows.—A trial with two cows "to determine how much land would be required to produce sufficient food for them during the summer season." The food consisted of permanent pasture, first and second growth clover, alfalfa, peas, and oats. From June 10 to September 26 the food consumed by the two cows was cut from an area of 1.56 acres, or 0.78 acres per animal.

Feeding steers of different breeds.—A record of progress in an experiment to compare "the merits of the grades of the principal breeds of cattle in Ontario for beef production."

Berkshire vs. Improved Yorkshire pigs.—A record of one young pig of each breed fed on milk and a grain mixture during 5 months. During this time the Berkshire ate 30 pounds more grain and gained 12.5 pounds more than the Improved Yorkshire.

Feeding experiments with hogs, G. Harcourt (pp. 206–211).—Several experiments are reported which were made to ascertain the amount of food required to produce a pound of gain in pigs of different weights, and to test the value of wheat bran for pigs. The results of the latter trial indicate that bran in connection with skim milk and buttermilk is a good food for hogs. "In these experiments we notice a steady increase, as the animals get older and heavier, of the amount of food required to lay on 1 pound of flesh. * * * Young pigs are the cheapest to feed and should be turned off about the time they attain a weight of 150 pounds live weight, as the least amount of food, as a rule, will then be required to produce a pound of flesh."

Fodder corn and the silo, G. Harcourt (pp. 211–218).—*Method of seeding.*—An experiment is reported in which Pearce Prolific corn was grown for silage in drills 3, 3½, and 4 feet apart, using from 35 to 15 pounds of seed per acre. The largest yield was realized where 15 pounds of seed per acre were sown in drills 4 feet apart, and the next largest with 18 pounds of seed per acre and drills 3½ feet apart.

Varieties of corn.—Tabulated data for 44 varieties.

Growth of corn.—The average growth of the leaves and tassels of corn during August is tabulated for 28 plants. The author concludes that, "all other things being equal, the rapidity of growth depends on the weather. This was noticed very markedly. A fine, hot day always resulted in a very rapid growth—as high as 3 inches in the 24 hours, and in one or two cases as high as 5 inches. If the day was cold the growth was very slow, in some cases none at all. The growth during the night was *nil*."

Proceedings of the Ontario Agricultural and Experimental Union (pp. 221–262).—The eleventh annual meeting of the Union was held at the Ontario Agricultural College, January 6 and 7, 1890. The annual

address of the President was delivered by J. A. Craig. Papers were presented on the following topics: The Mineral Exhaustion of Soils, by A. E. Shuttleworth; Barns for Ontario, by J. B. Bowes; The Scientific Principles Underlying the Making and Feeding of Corn Silage, by C. C. James; Chemistry of Dairy Products, by A. E. Rennie; Corn and Hogs as Source of Profit in Farming, by B. Robinson; The Farmer's Son before and after a Course at College, by J. B. Muir; The Need and Uses of Experimental Work in Dairying, by J. W. Robertson; Barley Growing in Ontario, by T. G. Raynor.

Determination of fat in milk, C. C. James (*Ontario Agr. College Expt. Sta. Bul. No.* 61, *April* 15, 1891, *pp.* 6)—This is a description of the Babcock centrifugal method of determining the percentage of fat in milk, together with a report on the accuracy of the results obtained from this method. In four comparisons with gravimetric methods, the widest variation was 0.11 per cent. A test of milk while fresh and after standing until very sour gave the same results (3.6 per cent) of fat. "If the bottles are accurately graduated and the instructions followed, I consider the method exceedingly satisfactory." Illustrative of the use which may be made of the method, the average composition for one week of the milk of each of six cows used in a feeding experiment, is appended.

The author suggests a modification of the method by adding 3 c. c. of a mixture of amyl alcohol and hydrochloric acid at the time the sulphuric acid is added, and whirling the bottles at ordinary temperature, instead of filling the water jacket with hot water. This change makes the method practically the same as the Vermont Station method, as he uses in some cases the Beimling centrifugal.

Bark louse and pear tree slug, J. H. Panton (*Ontario Agr. College Expt. Sta. Bul. No.* 62, *April* 25, 1891, *pp.* 7, *figs.* 9).—Brief notes on the oyster-shell bark louse (*Mytilaspis pomorum*) and pear tree slug (*Selandria cerasi*), with suggestions as to remedies.

Pitting the sugar beet, C. C. James (*Ontario Agr. College Expt. Sta. Bul. No.* 63, *May* 15, 1891, *pp.* 8).—This includes brief general statements regarding the preservation of sugar beets in winter, a description of the earth pits or silos used in Europe for the storage of beets, and short records of experiments at the station in storing beets in a similar pit. The sugar beets grown at the station in 1890 were stored in a pit from harvest until March 12, 1891. "Shortly afterwards the beets were fed to the stock. In general appearance the beets seemed about the same as when first pitted, except that sprouting had taken place in some." The analyses of 12 samples from the pit gave an average of 12.54 per cent of sugar in the juice with a purity coefficient of 82.20, as compared with an average of 14.77 per cent of sugar and a purity coefficient of 81.97 for 53 samples analyzed soon after harvesting.

Allowing for any errors in sampling, we can safely conclude that the beets lost about 2 per cent of sugar in the silo; that the coefficient of purity, however,

remains about as before; and that the beets, even after being preserved 5 months in a simple earth silo, came out in a condition very favorable to the production of sugar. There seems to be no doubt that in this province the sugar beet can be preserved as long as necessary through our winter months in a condition suitable for sugar making.

The following are analyses of beets from the pit as compared with turnips and mangel-wurzels from the farm root cellars, all samples being taken near the end of March, with a view to determining their value for stock feeding.

Composition of sugar beets, turnips, and mangel-wurzels.

	Water.	Crude protein.	Crude fat.	Carbo-hydrates.	Crude fiber.	Crude ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
(1) Dry:						
Sugar beets		9.03	0.67	80.39	6.09	3.82
Turnips		11.89	1.35	73.73	8.57	4.46
Mangel-wurzels		17.69	0.91	67.98	6.44	6.98
(2) As fed:						
Sugar beets	82.93	1.54	0.11	13.73	1.04	0.65
Turnips	87.09	1.54	0.17	9.53	1.10	0.58
Mangel-wurzels	91.00	1.59	0.08	6.12	0.58	0.63

Silage and roots for swine. T. Shaw (*Ontario Agr. College Expt. Sta. Bul. No.* 64, *May* 28, 1891, *pp.* 8).—This experiment, the object of which was "to ascertain the value of corn silage and roots as food adjuncts in feeding swine in the winter season" and "to demonstrate the extent of the loss for feeding swine after they have become fit for slaughter," was made with 9 Berkshire pigs about 7 months old and averaging about 150 pounds in weight at the commencement of the experiment. They were divided into three lots (one barrow and two sows in each) which were fed from December 4, 1890, to March 4, 1891, 90 days, as follows: Lot 1 were fed all they would eat, about 4.5 pounds each per day, of a grain mixture composed of two parts by weight of ground peas and one part each of ground oats, ground barley, and wheat midlings; lots 2 and 3 were each fed about one half as much of the same grain mixture as lot 1, lot 2 receiving turnips, and lot 3 silage, *ad libitum.* The pigs of lot 2 consumed on an average about 13.7 pounds of turnips, and those of lot 3 about 6.9 pounds of silage each per day. The silage was cut into pieces about 1½ inches long. Only the more succulent portions were eaten, the other portions being merely chewed. In estimating the pecuniary results the grain mixture was valued at 1 cent per pound, the turnips at 8 cents per bushel, and the corn silage at $2 per ton, and no mention is made of any allowance being made for the value of the manurial residue.

At the close of the feeding lot 2 (grain and turnips) were "not in prime condition," and lot 3 (grain and silage) were not in much better condition than at the beginning of the feeding.

The pigs were all valued at the beginning of the experiment at $3.75 per hundred pounds live weight. At the close the price of pork was

somewhat higher and lot 1 were valued at \$4.50, lot 2 at \$4.15, and lot 3 at \$4 per hundred live weight. The average results are tabulated. These show that while the three pigs in lot 1 (grain alone) made an aggregate gain in live weight of 263 pounds during the 90 days, those of lot 2 (grain and turnips) gained only 163.5 pounds, and those of lot 3 (grain and silage) only 71 pounds. The increase made by lot 1 was valued at \$3.08 more than the first cost of the food eaten; and that made by lot 2 at \$2.59, and by lot 3 at \$4.08 less than the cost of the food.

At the close of the above experiment the three lots were fed for 47 days longer, each being given alike all they would eat of the grain mixture. The animals averaged at this time from 180 to 240 pounds each in live weight. The average increase in live weight per animal during this after feeding was, lot 1, 6.7 pounds; lot 2, 43.7 pounds; and lot 3, 73.3 pounds. At the close of this experiment the animals were all slaughtered. At 4½ cents per pound of live weight produced the value of the increase was only sufficient in the case of lot 3 to cover the first cost of the food.

The conclusions of the author that "pigs should be finished for market at an early age to get the best results," are in accordance with those reached elsewhere.

Ginseng, **J. H. Panton** (*Ontario Agr. College Expt. Sta. Bul. No.* 65, *June* 15, 1891, *pp.* 7, *fig.* 1).—A brief description of ginseng (*Aralia quinquefolia*), with statements regarding its cultivation and distribution. This plant is exported in large quantities to China, where it is used for medicinal purposes. Canada alone is stated to have exported the roots of this plant to an amount valued at \$100,000 in 1890, and the legislature of Ontario at its last session passed an act, the text of which is given, forbidding the gathering of the roots of ginseng in uncultivated land between January 1 and September 1.

EXPERIMENT STATION NOTES.

Delaware College.—W. H. Bishop, B. S., formerly of Tongaloo University, Mississippi, has been appointed professor of agriculture in the Delaware College.

Georgia Station.—The station has completed a four-room building for office purposes, and now has in process of erection a two-story building 32 by 48 feet to serve for ginnery, farm machinery and implements, and a dairy 16 by 20 feet with a cellar 12 by 12 feet in the center of which is a well. The series of experiments in hybridization and cross-fertilization of species and varieties of cotton commenced last year, is still in progress and promises interesting results. Varieties of cotton from Egypt, central Asia, India, and South America enter into the experiments. Flowers of *Gossypium* pollinated with pollen from okra (*Hibiscus esculentus*) resulted in apparently perfect bolls of cotton, but the seed when planted in 1891 failed in every instance to germinate. On the other hand when okra was used on the female parent the resulting seed germinated as usual, but the plants were identical in appearance with the original okra parent plant, with the exception that the period of blooming and fruiting was very greatly delayed.

Illinois Station.—S. H. Peabody, Ph. D., LL. D., resigned his position as president and member of the board of direction of this station August 7, and George E. Morrow, M. A., was elected in his place.

Iowa Station.—Feeding experiments are in progress at this station with soaked corn for Poland China, Chester White, and Jersey Red pigs, and Shropshire lambs, and comparative tests of soiling crops and pasturage. Seven breeds of sheep and twenty head of steers, representing three different breeds, have been obtained for the purpose of conducting feeding experiments. A forthcoming bulletin of the station will contain among other things reports of a feeding experiment with gluten meal, and comparative tests of "sugar meal" *vs.* corn meal, and skim milk *vs.* whole milk.

Mississippi Station.—Tait Butler, D. V. S., has been appointed veterinarian to the Mississippi Station.

Pennsylvania Station.—J. W. Fields has been appointed assistant chemist vice H. B. McDonnell, M. D.

Virginia College and Station.—J. M. McBryde, Ph. D., LL. D., has been appointed director of the station and president of the college vice W. D. Saunders, resigned, and entered upon his duties August 1. The organization of the station is at present as follows: J. M. McBryde, Ph. D., LL. D., president of the college and director; R. J. Davidson, M. A., acting chemist; T. L. Watson, assistant chemist; E. A. Smyth, jr., M. A., botanist; W. B. Alwood, horticulturist, entomologist, and mycologist; R. H. Price, assistant horticulturist; D. O. Nourse, agriculturist and farm superintendent.

Wyoming Station.—The director of the station, D. McLaren, M. S., has made an extended tour of the State, with special reference to the agricultural and grazing interests, and has visited the experiment farms at Lander, Laramie, Saratoga, Sheridan, Sundance, and Westland. The aims and methods of the experiment station have been explained to meetings of farmers in various parts of the State.

GERMANY.—The sixty-fourth convention of the Association of German Naturalists and Physicians will be held at Halle from September 21 to 25, 1891.

The sections of the Association include those for physics, chemistry, botany, physiology, pharmacology, pharmacy and pharmacognosy, hygiene, agricultural chemistry and experimentation, and scientific instruments and apparatus.

The president of the section for agricultural chemistry and experimentation is Professor Maercker, director of the experiment station of the Central Agricultural Society of the Prussian Province of Saxony at Halle. The program for this section is not yet complete, but it is expected that papers will be presented, among others, by Professors Maercker, Hellriegel of Bernburg, Nobbe of Tharand, and Albert of Halle, the subjects of which have not yet been announced; by R. W. Bauer on (*a*) Normal Soil, (*b*) Field Experiments on Sandy Plains, and (*c*) The Sugar of the Fruit of the Dog Rose; and the following by Professor Maercker's assistants: Dr. Morgan, The Adulteration of Thomas Slag; Dr. Cluss, The Application of Hydrofluoric Acid in the Brewing Industry; and Dr. Gerlach, The Solubility of the Phosphoric Acid of the Soil, and its Relation to the Yield.

It is expected that Professor Atwater of this Office, will attend the meeting of the Association, and will furnish for the Record a report of the proceedings as far as they are of interest to agriculture.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING AUGUST, 1891.

Division of Ornithology and Mammalogy:

North American Fauna, No. 5.—Results of a Biological Reconnoissance of South-Central Idaho; Descriptions of a New Genus and Two New Species of North American Mammals.

Division of Statistics:

Report No. 87 (new series), August, 1891.—Report of the Condition of Growing Crops; Freight Rates of Transportation Companies.

Office of Experiment Stations:

Experiment Station Record, vol. III, No. 1, August, 1891.

Miscellaneous Bulletin No. 3.—Proceedings of the Fourth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING AUGUST, 1891.

AGRICULTURAL EXPERIMENT STATION OF FLORIDA:

Bulletin No. 13, April 1, 1891.—Irish Potatoes, Rye, and Fertilizers.

GEORGIA EXPERIMENT STATION:

Special Bulletin No. 12½, July, 1891.—Circular to the Farmers of Georgia from the Board of Directors.

Bulletin No. 13, July, 1891.—Analyses of Feeding Stuffs; Forage Plants.

KANSAS AGRICULTURAL EXPERIMENT STATION:

Third Annual Report, 1890.

MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 40, July, 1891.—Weather Record April–June; some Diseases of Lettuce; Fertilizer Analyses; Feeding Experiments with Steers.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:

Meteorological Bulletin No. 31, July, 1891.

MISSOURI AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 15, July, 1891.—Tests of Varieties of Wheat and Oats; Change of Seed of Wheat, Oats, and Potatoes.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 78, July 10, 1891.—Some Injurious Insects.

Bulletin No. 77*b*, July 1, 1891.—The Injury of Foliage by Arsenites; a Cheap Arsenite; Combination of Arsenites with Fungicides.

Bulletin No. 75*c*, April 28, 1891.—Meteorological Summary for North Carolina, February and March.

OHIO AGRICULTURAL EXPERIMENT STATION:

Ninth Annual Report, 1890.

THE PENNSYLVANIA STATE COLLEGE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 16, July, 1891.—Culture of the Chestnut for Fruit; Analysis of Several Varieties of Chestnuts.

TEXAS AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 15, May, 1891.—Influence of Climate on Composition of Corn; Digestibility of Food Stuffs; Miscellaneous Analyses.

Bulletin No. 16, June, 1891.—Work in Horticulture; Drainage Experiments.

AGRICULTURAL EXPERIMENT STATION OF UTAH:

Bulletin No. 7, July, 1891.—Draft of Mowing Machines.

VIRGINIA AGRICULTURAL AND MECHANICAL COLLEGE EXPERIMENT STATION.

Bulletin No. 10, June, 1891.—Steer and Pig Feeding.

WYOMING AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 2, August, 1891.—Plant Lice.

DOMINION OF CANADA.

ONTARIO AGRICULTURAL COLLEGE EXPERIMENT STATION:

Bulletin No. 67, August 12, 1891.—Winter-Wheat Experiments.

BUREAU OF INDUSTRIES, TORONTO, ONTARIO:

Bulletin No. 37, August 8, 1891.—Crops and Live Stock in Ontario.

U. S. DEPARTMENT OF AGRICULTURE

OFFICE OF EXPERIMENT STATIONS

A. W. HARRIS, DIRECTOR

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EXPERIMENT STATION RECORD.

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EDITORIAL NOTES.

The Association of American Agricultural Colleges and Experiment Stations held its fifth annual convention August 12–18 at Washington, District of Columbia, in the lecture rooms of the Columbian University. There were present 125 delegates and representatives of colleges and stations in 37 States and Territories, and of the United States Department of Agriculture. About the same time occurred the meetings of the American Association for the Advancement of Science, the Association of Official Agricultural Chemists, the Society for the Promotion of Agricultural Science, the Association of Economic Entomologists, and the Conference of American Chemists.

A salient feature of the convention of colleges and stations was the lectures of Mr. R. Warington, F. R. S., chemist of the experiment station at Rothamsted, England. This course of six lectures was the first to be delivered under the provisions of the Rothamsted trust, instituted by Sir John Bennet Lawes, and referred to in a previous number of the Experiment Station Record (see vol. III, p. 73). The subjects treated were: The Rothamsted Experimental Station; the circumstances which determine the rise and fall of nitrogenous matter in the soil; nitrification; nitrification and denitrification; nitrification of soils and manures; drainage and well waters. Mr. Warington's description of the work of the Rothamsted Station and his more detailed accounts of the processes and results of the investigations of problems of nitrification were followed with much interest by the scientists present, and will constitute a valuable contribution to the literature of scientific investigations in agriculture. A full report of these lectures and of the proceedings of the convention will be issued as bulletins of this Office at an early date.

Dr. H. H. Goodell, president of the Massachusetts Agricultural College and director of the Massachusetts Hatch Station, presided at the session of the first day of the convention, but was afterwards compelled

by indisposition to yield the chair to Vice Presidents Roberts of New York and Porter of Missouri for the remainder of the meeting. In his annual address President Goodell urged the necessity for untiring patience and perseverance in scientific research in order to attain the highest success, enforcing his argument with illustrations from the lives of eminent workers in general and agricultural science and from the carefully planned and thoroughly executed experiments conducted for so many years by the Rothamsted Station.

In accordance with the plan adopted by the Association, the section on agriculture presented two topics deemed of general interest to the convention. The first was the question, "How can the results of station work be most successfully presented to the farmer?" The leaders in the discussion of this question were Director Roberts of New York and President Scott of New Jersey. Mr. Roberts urged that the station worker make himself thoroughly familiar with the environment and life of the average farmer. Since the work of the farmer was so exacting as to leave him but little time and strength for reading, the station bulletins should be attractive in appearance, brief in form, and simple in language. Well-executed illustrations would greatly enhance the popularity and practical benefits of these publications. Mr. Scott laid special emphasis on personal contact of the station worker and the farmer as a means of inducing the latter to apply the information gained by scientific research in the improvement of agricultural methods and products. He outlined a plan about to be put into execution by the New Jersey Station for sending lecturers throughout the State to address the farmers at meetings of their various organizations.

Another topic was presented by Professor Morrow of the Illinois College and Station, in a paper on the relations which should exist between the investigator and the teacher. In his opinion these two classes of workers might do each other and the cause of agricultural science a great service by cultivating relations of mutual helpfulness. The teacher should know what is going on in the laboratory and field so that he might be able to bring to his pupils new truths or fresh illustrations of old ones. The investigator, on the other hand, needed to know the difficulties and questionings which presented themselves in the class room with reference to the problems he was investigating. By this means he would be better able to learn how to state processes and results of his researches so as to make his reports clear and satisfactory.

The report of the executive committee, covering a period of nine months ending August 12, 1891, was submitted by its chairman, President Alvord of Maryland.

The report of the section on botany, presented by Professor Halsted of New Jersey, showed that the station botanists had been especially active in studies on the diseases of plants and their prevention, and that results of much practical importance had followed their investigations.

In the report of the section on chemistry, presented by Director Neale of Delaware, the work of the station chemists was classified under the following heads: (1) Detective duty, (2) agricultural manufactories, (3) work of immediate value in directing farm management, (4) development of analytical methods and invention of apparatus, (5) investigations of interest chiefly to students and scientists. The report also urged the desirability of coöperation among the workers in different branches of agricultural science in order that the practical ends, which were the real object of experiment station work, might be most speedily and effectually attained.

The report of the secretary and treasurer, Director Scovell of Kentucky, showed that at the adjournment of the Champaign convention in November, 1890, the indebtedness of the Association amounted to $1,190.19, and that the expenses incurred by the executive committee during the year were $216.84, making the total liabilities of the Association for this period $1,407.03. The amount received during the year was $1,716.52, leaving a cash balance of $309.49 in the treasury of the Association.

The report of the committee on a coöperative station exhibit at the World's Columbian Exposition was presented by Director Armsby of Pennsylvania. From this it appeared that much interest in the project has been manifested by the stations, and that they thoroughly appreciate the value of the opportunity afforded by the Exposition to bring their work prominently before the public. Favorable responses to circulars describing plans for the proposed exhibit had been received from nearly all the stations. The plan for the exhibit proposed by the committee was accepted, and it was voted to continue the committee until the close of the Exposition. The action of the convention, taken in connection with the favorable replies which the committee has received from the stations, gives assurance that the exhibit will be both creditable to the stations and instructive to the public. A special committee was appointed to coöperate with the World's Congress Auxiliary in relation to an agricultural congress to be held during the Exposition as one of a series of congresses on scientific, educational, and social subjects.

The question, What coöperation is desirable between the colleges and stations and the Weather Bureau of the Department of Agriculture? was discussed by Assistant Secretary Willits and others. Communications from Prof. M. W. Harrington and Major H. W. Dunwoody of the Weather Bureau were read in this connection. As the outcome of this discussion, a committee, consisting of Messrs. Smith of Minnesota, Harris of this Office, and Alvord of Maryland, was appointed to consider the whole subject. This committee subsequently reported the following resolutions, which were adopted:

Resolved, That in the future development and extension of the Weather Bureau in the special interests of agriculture, the Bureau should organize and assist in maintaining a study of climatology in its relations to farming, in coöperation with

agricultural colleges and stations; and that the sphere of this work should be enlarged to include the physics, conditions, and changes of agricultural soils.

Resolved, That a special committee be appointed by this Association to confer with the officials of the Department of Agriculture in furthering the object stated and in bringing the same to the attention of Congress.

Messrs. Alvord, Harris, and Henry of Wisconsin were appointed as the special committee called for by this resolution.

Hon. William T. Harris, United States Commissioner of Education, addressed the convention regarding reports by the colleges and stations to the Bureau of Education under the act of Congress of 1890. He was requested to prepare and forward to the colleges and stations blank forms for these reports. A letter was received from Hon. Justin S. Morrill expressing his appreciation of the vote of thanks passed by the Association at its last convention for the services rendered by him in securing legislation relative to the colleges.

The following resolutions, among others, were agreed to:

Resolved, That a committee of three, especially representing the colleges of agriculture and mechanic arts, be appointed to consider the subject of a collective agricultural college exhibit in the agricultural building of the World's Columbian Exposition, and with power to represent the interests of the Association in this connection.

Resolved, That this Association renew its expression of sincere thanks to Sir John Bennet Lawes for his munificent provision for a course of lectures on the work done at Rothamsted, to be delivered biennially in the United States, and that it also wishes to express its sincere thanks to Mr. R. Warington for consenting to deliver the first series of lectures, and its appreciation of the high scientific and practical value of the course delivered at this meeting.

It was decided that no adjourned session of the convention should be held during the present year.

The following were elected officers of the Association for the ensuing year: President, W. L. Broun of Alabama; vice presidents, C. W. Dabney of Tennessee, J. W. Nicholson of Louisiana, H. E. Stockbridge of North Dakota, F. E. Emery of North Carolina, and W. H. Jordan of Maine; secretary and treasurer, M. A. Scovell of Kentucky; executive committee, H. E. Alvord of Maryland, H. H. Goodell of Massachusetts, J. A. Myers of West Virginia, W. Frear of Pennsylvania, and A. T. Neale of Delaware.

Section on agriculture: Chairman, C. L. Ingersoll of Nebraska; vice chairman, G. W. Curtis of Texas; secretary, T. F. Hunt of Pennsylvania. Section on botany: Chairman, G. F. Atkinson of Alabama; secretary, L. H. Pammel of Iowa. Section on chemistry: Chairman, M. A. Scovell of Kentucky; secretary, H. H. Harrington of Texas. Section on college work: Chairman, E. M. Turner of West Virginia; vice chairman, C. H. Pettee of New Hampshire; secretary, H. E. Stockbridge of North Dakota. Section on entomology: Chairman, L. Bruner of Nebraska; secretary, F. M. Webster of Ohio. Section on horticulture: Chairman, E. A. Popenoe of Kansas; secretary, T. L. Brunk of Maryland.

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Connecticut State Station, Bulletin No. 108, May, 1891 (pp. 11).

EXAMINATION OF THE SEED OF ORCHARD GRASS (pp. 2–4).—The tabulated results are given of botanical analyses and germination tests made at the station of 17 samples of orchard-grass seed, 6 of which were bought of seedsmen in the State, 6 from Boston, and 5 from New York. The results of these examinations are summarized as follows:

Of the 17 samples 1 sample contained as much as 98.8 per cent of pure seed, the remainder being chaff. Another contained no orchard-grass seed whatever, and consisted mainly of *Lolium perenne*, or perennial rye grass. Excluding this sample, the other 16 samples contained on the average 77.4 per cent of pure seed.

Seven out of 16 samples contained notable quantities (from 8.3 to 35.5 per cent) of seed of perennial rye grass, which is less valuable and sells at a lower price. "Tested" orchard-grass seed is quoted at 11 cents per pound and tested perennial rye grass at 4½ cents. A single sample contained 14.1 per cent of a species of *Bromus*, probably *secalinus*, or chess.

In 1 sample as high as 88 per cent of the orchard-grass seed sprouted, in another as low as 4.5 per cent, and on the average of 16 samples 50 per cent.

Taking the 16 samples together, the average quantity of pure orchard-grass seed which was capable of sprouting was 40 per cent; *i. e.* out of every 100 pounds bought 40 pounds was pure, live seed. Probably the quantity that would produce healthy plants was less than this.

ASH ANALYSIS OF WHITE GLOBE ONIONS (pp. 4, 5).—Twenty-two fair-sized White Globe onions were selected from several barrels for analysis. The fresh onions contained 0.27 per cent of nitrogen and 0.48 per cent of ash. The composition of the pure ash and the calculated amount of ash ingredients in 1 ton of onions are given as follows:

Analysis of White Globe onions.

	In 100 parts of ash.	In 2,000 pounds of onions (bulbs).
		Pounds.
Nitrogen		2.70
Phosphoric acid	19.08	0.92
Potassium oxide	43.49	2.09
Sodium oxide	1.26	0.06
Calcium oxide	10.87	0.52
Magnesium oxide	4.46	0.21
Oxide of iron	1.07	0.05
Sulphuric acid	15.98	0.77
Chlorine	2.36	0.11
Sand and silica	1.96	0.09

THE DETERMINATION OF FAT IN CREAM BY THE BABCOCK METHOD (pp. 5-11).—This is a comparison of fifty samples of cream of the percentages of fat indicated by the Babcock centrifugal method and by the gravimetric method of the laboratory. In all except ten cases a pipette made by A. L. Winton, jr., which delivered quite accurately 6 grams of cream, was used in measuring the cream for the Babcock test. After measuring into the test bottles the cream was diluted with 12 c. c. of water, the test made as usual, and the reading of fat in the graduated tube multiplied by 3. This pipette is said to do away with the correction otherwise necessary in testing cream by this method. In 26 cases the Babcock method gave higher results and in 24 cases lower results than the gravimetric method. The greatest difference was 0.56 per cent. The difference between the two methods was in 18 cases a tenth of 1 per cent or less; in 35 cases it was less than a quarter of 1 per cent; and in 7 cases it exceeded a third of 1 per cent.

In considering these figures and the accuracy of the method it must be borne in mind that the per cent of fat is from four to six times as great in cream as in milk, and hence a larger difference in the percentage of fat found in cream by the two methods may not involve any larger proportion of the total quantity of butter fat than a much smaller difference in the per cent of fat found in milk by the two methods involves in the total quantity of the fat of milk. * * *

The results above given lead us to believe that the Babcock method may be made of very great value to cream-gathering creameries. It offers to them a practical and accurate method of ascertaining the actual quantity of butter fat which each patron furnishes, so that payments may be based not on volume of cream supplied, but on actual butter fat, which is the raw material that the creamery manufactures. This is obviously the most satisfactory method of payment. For this purpose each patron's cream should be weighed and sampled, and the fat in it determined by the method described.

The station proposes to study the practical working of this method at a creamery.

Delaware Station, Bulletin No. 13, July, 1891 (pp. 16).

LEAF BLIGHT OF THE PEAR AND THE QUINCE, F. D. CHESTER, M. S. (plates 2, figs. 3).—This includes a description of the effects of this disease on leaves and fruit, a brief account of the leaf-blight fungus (*Entomosporium maculatum*), formulas for the fungicides used in experiments by the author, and accounts of experiments in spraying diseased trees in four localities in Delaware. In the case of one of the experiments, where five applications were made between May 10 and July 21, the following percentages of sound fruit are reported for each fungicide used: Modified eau celeste 85.1, Bordeaux mixture 84.4, precipitated carbonate of copper 80.8, ammoniacal carbonate of copper 78.3, carbonate of copper and carbonate of ammonia 66.3, no fungicide 42.

So far as the effect of the several mixtures upon the preservation of the foliage is concerned, there seemed to be no appreciable difference in their efficiency. * * *

The relative cost of the materials in these several fungicides was during the season of 1890 as follows, per 100 gallons: Carbonate of copper and carbonate of

ammonia mixture 25¼ cents, precipitated carbonate of copper 31 cents, modified eau celeste 40 cents, ammoniacal carbonate of copper 57⅘ cents, Bordeaux mixture $1.51.

These costs were based upon the following market quotations per pound: Sulphate of copper 5⅝ cents, salsoda 1¼ cents, strong ammonia (26°) in carboys 7 cents, copper carbonate (home manufacture) 14 cents, carbonate of ammonia 10 cents.

In another experiment 1,000 pear trees were sprayed four times during the season with Bordeaux mixture, at a total cost for labor (4 days at 75 cents) and the fungicide of $22, or 2.2 cents per tree. In an experiment with quinces the ammoniacal compound of copper did not give good results, but when the Bordeaux mixture was used the progress of the disease was staid. The author concludes in general that his experiments teach:

(1) That the ammoniacal carbonate of copper, the modified eau celeste, the carbonate of copper and carbonate of ammonia mixture, and the Bordeaux mixture will all control the leaf blight of the pear and prevent the fall of the foliage.

(2) That the ammoniacal carbonate of copper when used in excess is apt to injure the foliage and produce a russeted appearance of the fruit.

(3) That the carbonate of copper and carbonate of ammonia has this effect to a less degree, that it is cheaper and equally if not more effective.

(4) That the Bordeaux mixture is too expensive and troublesome a mixture, except in very serious cases.

(5) That the modified eau celeste, and the carbonate of copper and carbonate of ammonia mixture are the two cheapest as well as most effective fungicides for the treatment of this disease.

Florida Station, Bulletin No. 13, April 1, 1891 (pp. 28).

EXPERIMENTS WITH POTATOES AND RYE, J. P. DEPASS (pp. 4–8).—A brief account is given of an experiment with composts and commercial fertilizers on Beauty of Hebron and Burbank potatoes planted January 31. This experiment was in continuation of that reported in Bulletin No. 11 of the station (see Experiment Station Record, vol. II, p. 491).

The first of a series of experiments with rye grown for green forage in the winter is also reported. The rye was planted broadcast and in drills on three plats, on poor, sandy soil fertilized with manure and commercial fertilizers. On one plat the crop was cut for fodder and on another seven cattle and two colts were pastured. A considerable amount of green forage was easily and cheaply produced during the winter and early spring.

COMPOSITION AND VALUE OF CERTAIN MATERIALS FOR FERTILIZING PURPOSES, J. M. PICKELL, PH. D., AND J. J. EARLE, B. A. (pp. 9–28).—This article contains analyses of soft marl phosphate, and a discussion at considerable length of its value as a fertilizer; an account of an experiment made at the Connecticut State Station on the comparative value of finely ground and acidulated phosphates, taken from the Annual Report of that station for 1889 (see Experiment Station Record, vol. II, p. 483); analysis of a low-grade phosphate containing much

alumina, and of the same after treatment with sulphuric acid; analyses of a number of samples of muck, and a comparison of the average composition of the same with barnyard manure (average of 21 analyses made by the Massachusetts State Station); remarks on the methods of using muck, directions for composting, etc. Analyses are also given of bat guano and rice hulls, the latter with reference to its food ingredients.

The muck contains a great deal more nitrogen and much less potash and phosphate than the barnyard manure.

The muck contains comparatively much nitrogen, but is deficient in potash and phosphate. Hence in the use of muck as a fertilizer one should expect that it would need to be supplemented by potash and phosphate. * * *

Fifteen samples of our muck when perfectly dry contained between 56 and 97 per cent of organic matter, 12 of the 15 contained from 2 to 4 per cent of nitrogen, 3 less than 2 per cent, and 1 less than 1 per cent. Five samples contained less than 55 per cent of organic matter, 4 of which contained between 1 and 2 per cent of nitrogen, and 1 less than 1 per cent.

As is well known, plants of different kinds and different parts of the same plant contain different amounts of plant food. In the perfectly dry state, pea vines, for example, contain about 2 per cent of nitrogen, and wheat straw only about 1 per cent. One would naturally expect that a muck if formed by the disintegration of the former would contain more nitrogen than if by that of the latter. * * *

In judging of the value of a muck, three things at least are to be taken into account: (1) The kind or kinds of plants from which formed; (2) the quantity of organic matter in the muck; and (3) the stage of decomposition.

Georgia Station, Bulletin No. 12½, July, 1891 (pp. 8).

CIRCULAR TO THE FARMERS OF GEORGIA FROM THE BOARD OF DIRECTORS (pp. 55–60).—This special bulletin contains general statements regarding the history, organization, funds, publications, and work of the station, published with a view to increasing the interest of the farmers of the State in the work of the station.

Georgia Station, Bulletin No. 13, July, 1891 (pp. 12).

ANALYSES OF FEEDING STUFFS, H. C. WHITE, PH. D. (pp. 61–65).—This includes a study of the composition of six different varieties of sorghum and of pearl millet at different stages of growth; analyses of the kernels, cob, and stover of Brazilian flour corn; of the tubers and vines of five varieties of sweet potatoes; and of the plant, fruit, and parts of the fruit of Spanish and Georgia peanuts. The analyses are given as follows:

Percentage composition of sorghum and pearl millet.

	Amber cane.	White millo maize.	Yellow millo maize.	Kaffir corn.	Rural Branching sorghum.	Link Hybrid sorghum.	Pearl millet.
Cut when in bloom.							
Water	43.62	45.20	50.18	51.76	41.14	47.20	49.50
100 parts of dry matter contained:							
Crude protein	6.94	5.23	8.31	6.25	8.26	8.35	4.94
Nitrogen-free extract	45.65	46.96	45.66	36.24	41.42	43.21	44.53
Crude fiber	35.85	37.46	34.25	46.67	39.33	36.36	39.70
Crude fat	5.92	5.20	4.12	4.24	5.25	5.70	4.11
Crude ash	5.64	5.15	7.66	6.60	5.74	6.38	6.72
Seeds in the dough.							
Water	41.70	38.65	43.24	52.10	50.15	38.60	39.80
100 parts of dry matter contained:							
Crude protein	5.44	4.87	4.92	5.30	4.60	3.93	4.94
Nitrogen-free extract	55.26	55.90	51.79	41.98	50.36	52.84	44.40
Crude fiber	29.21	30.30	34.50	43.91	35.11	33.20	39.70
Crude fat	5.03	4.15	3.72	3.80	4.11	4.60	4.24
Crude ash	5.06	4.78	5.07	5.01	5.82	5.43	6.72
Seeds ripe, heads.							
Water	20.15	19.86	21.32	24.18	20.20	19.90	*25.60
100 parts of dry matter contained:							
Crude protein	8.81	9.95	11.45	11.12	10.35	11.38	5.80
Nitrogen-free extract	73.16	65.10	65.30	63.00	64.76	65.23	46.58
Crude fiber	11.05	17.34	14.66	17.36	16.32	15.40	38.65
Crude fat	3.86	3.28	4.27	5.14	4.86	4.32	3.15
Crude ash	3.12	4.33	4.12	3.38	3.71	3.67	5.82
Stalks.							
Water	35.71	36.36	38.41	32.35	37.61	35.40	(*)
100 parts of dry matter contained:							
Crude protein	4.56	3.72	3.15	6.75	3.11	2.88	......
Nitrogen-free extract	55.95	61.10	61.04	40.40	58.95	62.00	......
Crude fiber	30.11	27.22	28.73	44.55	30.24	27.45	......
Crude fat	5.12	3.20	2.34	2.19	2.58	2.15	......
Crude ash	4.26	4.76	4.74	6.11	5.12	5.52	......

* The stalk and seed-head of pearl millet were cut together and analyzed as cut.

Composition of kernels, cob, and stover of Brazilian flour corn.

	Water.	100 parts dry matter contained—				
		Crude ash.	Crude cellulose.	Crude fat.	Crude protein.	Nitrogen-free extract.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Kernels	13.28	3.26	2.26	2.87	12.55	79.06
Cob	11.25	10.87	41.59	1.01	1.66	44.87
Stover	34.62	6.11	29.42	1.76	6.38	56.33

The ear taken for analysis weighed 567 grains, of which the kernels weighed 446.51 grains, and the cob 120.49 grains; percentage of kernels 78.75, of cob 21.25.

[The low percentage of fat in the kernels as compared with Indian corn, and the exceptionally high percentage of ash in the cob are noticeable.]

Composition of sweet potatoes.

Variety.	Vines.						Tubers.						
	Water.	100 parts dry matter contain—					Water.	100 parts dry matter contain—					
		Crude ash.	Crude fat.	Crude cellulose.	Crude protein.	Nitrogen-free extract.		Crude ash.	Crude fat.	Crude cellulose.	Crude protein.	Total sugar.*	Nitrogen-free extract.†
	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Early Jersey	46.32	9.70	4.77	32.20	9.08	44.75	71.26	4.14	1.02	4.80	6.60	9.08	74.36
Southern Queen	47.15	11.26	4.32	27.39	8.38	48.65	70.40	4.12	1.00	5.13	5.03	8.45	76.27
Georgia Yarn	41.55	9.90	3.62	23.26	13.12	50.10	72.32	3.25	0.96	4.01	3.73	9.09	78.96
Pumpkin Yam	39.82	......	......	......	......	......	73.26	3.34	0.84	4.11	4.72	9.23	77.76
Poplar Root	40.62	10.92	3.78	16.88	13.35	55.07	71.60	3.01	1.04	3.63	4.08	8.02	80.22

* Calculated as cane sugar. † Exclusive of sugar.

Analysis of the plant and fruit of Spanish and Georgia peanuts.

	Vines.				Kernel of the fruit.		Hull of the fruit.		Roots of vines.	
	Cut before blooming.		Cut when fruit was ripe.							
	Spanish.	Georgia.	Spanish.	Georgia.	Spanish.	Georgia.	Spanish.	Georgia.	Spanish.	Georgia.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Water	32.62	29.78	31.43	32.38	13.15	12.85	19.20	20.62	29.62	28.74
100 parts of dry matter contain:										
Crude ash	9.96	11.32	11.74	12.91	2.72	2.18	4.63	3.00	9.75	9.58
Crude cellulose	24.75	19.89	28.46	36.10	3.50	2.34	71.78	79.30	41.66	48.59
Crude fat	6.30	5.84	4.82	5.22	41.17	43.13	2.08	2.12	4.31	3.20
Crude protein	12.69	12.57	11.71	9.91	32.18	30.49	7.19	4.99	8.78	7.63
Nitrogen-free extract	46.30	50.38	43.77	35.86	20.43	21.86	14.32	10.59	35.50	31.00

The relative proportions of hull and kernel in the fruit were: Spanish peanuts, hulls 22 per cent, kernels 78 per cent; Georgia peanuts, hulls 27 per cent, kernels 73 per cent.

FORAGE PLANTS, G. SPETH (pp. 66–72).—A popular discussion of the desirability of raising forage plants to be fed out on the farm, and remarks on commercial fertilizers, green manuring, barnyard manure, the selection of forage plants, and the cultivation of sorghum, teosinte, and pearl millet.

Teosinte (*Euchlæna luxurians*) is one of the most promising forage plants. It resembles corn, growing to a height of 6 or 8 feet, forming a mass of slender, succulent stems, with long, narrow leaves. It is of slow growth in the beginning, but shoots forward rapidly under the influence of our hot sun. Two cuttings were made last year, producing over 38,000 pounds of green food per acre, which was greatly relished by all kinds of farm stock. It is more affected by drouth than the sorghums, and requires a richer soil to do its best. It rarely reaches full maturity in our climate, while further south it ripens and produces seed. It is planted like corn, at a distance of 4 or 5 feet.

Illinois Station, Bulletin No. 16, May, 1891 (pp. 28).

This bulletin contains, in addition to reports of pig-feeding experiments and an article on composite milk samples, a table of contents and index to Bulletins Nos. 1–16, issued between May, 1888, and May, 1891.

EXPERIMENTS IN PIG FEEDING, G. E. MORROW, M. A. (pp. 497–504).

Corn vs. corn and grass.—Brief reports are given of four separate trials with Poland-China pigs, averaging in the different trials respectively 45, 178, 128, and 61 pounds each in weight. In each trial separate lots of pigs received (1) corn *ad libitum* ("full feed") and pasturage; (2) pasturage and a "half feed" of corn, which was changed to a full feed later; and (3) corn alone. The lots in the different trials consisted of from 3 to 5 pigs each, and the feeding lasted from 10 to 14 weeks. All were given coal slack and salt. Those given corn alone were kept in pens free from vegetation; the others were in a blue-grass pasture. The tabulated data show for each trial only the totals and averages of the corn consumed, gain in live weight, and gain per bushel (56 pounds) of corn. These indicate that during the first 6 or 8 weeks of each trial, when one lot received only the half feed of corn with pasturage, the gain made and the rate of gain per bushel of corn were best in the case of the pigs on the full ration of corn, either with or without pasturage, averaging rather better with pasturage. But during the following month, when all received a full feed of corn, the lot which had previously had only a half feed of corn with grass in each case made the largest total gain and the largest gain per bushel of corn.

Gain from dry corn alone.—A tabulated summary is given for eleven different lots of pigs, varying in weight from 65.5 to 311 pounds, which were fed exclusively on shelled corn with coal slack and salt, for periods ranging from 7 to 84 days.

The largest gain was 16.81 pounds per bushel by two pigs averaging 311 pounds in the fourth week of pen feeding. These two pigs had been on grass, with access to the droppings from two corn-fed heifers. * * * For 4 weeks their gain was at the rate of 14.66 pounds per bushel. In only one other case was this equaled in a period of 4 weeks. Two pigs averaging 209.27 pounds, fed from April 29 to May 27, gained at the rate of 14.73 pounds per bushel. In no case did pigs make satisfactory gains after 6 or 8 weeks' feeding on corn alone. * * *

The food required to make 1 pound of increase in weight in these trials depended less on the weight and age of the pigs than on other conditions [*i. e.* on the duration of the feeding, previous feeding, general condition, etc.].

Soaked vs. dry corn.—Two trials were made in each of which two pigs were fed soaked corn and two others dry corn, with no other food.

The pigs fed soaked corn ate more and gained more than those fed dry corn. In one trial they gained more and in one less in proportion to food eaten than those fed dry corn. The differences were not great in either case.

Value of droppings from corn-fed cattle for pigs.—The gains in weight are recorded for pigs receiving no other food than pasturage and the droppings of steers fed liberally on corn. In no case was the gain large.

Apple pomace silage.—A trial of silage made from apple pomace as food for pigs resulted unsatisfactorily. "The pomace kept well, and chemical analysis of it showed an apparently good composition for feeding purposes, but the pigs ate very little of it."

The composition of the pomace silage was as follows:

Analysis of silage from apple pomace.

	Fresh.	Water-free.
	Per ct.	*Per cent.*
Water	44.36	....
Crude ash	2.09	3.75
Crude cellulose	12.72	22.85
Ether extract	7.33	13.17
Crude protein	4.75	8.16
Nitrogen-free extract	28.75	52.07
	100.00	100.00

Includes the acids.

COMPOSITE MILK SAMPLES, E. H. FARRINGTON, M. S. (pp. 504–515, fig. 1).—This is in continuation of the work on the testing of milk at creameries, which was reported in Bulletin No. 14 of the station (see Experiment Station Record, vol. II, p. 565). In the investigation recorded in this article the use of composite samples in testing milk, as proposed by Patrick in Bulletin No. 9 of the Iowa Station (see Experiment Station Record, vol. II, p. 101), was the special subject studied. Separate tests were made by the Babcock centrifugal method of the milk brought by each of twenty patrons of a creamery for 7 consecutive days, as follows: The milk of each patron (1) was tested daily, and (2) a composite sample of the milk brought by each patron during the 7 days was tested at the end of that time, the composite sample being made up in two different ways—by taking one tenth of a quart of each day's milk, and by taking an amount each day proportional to the quantity of milk brought ($\frac{1}{1000}$, $\frac{1}{500}$, etc.). To prevent these composite samples from souring, from 15 to 20 grains of a mixture composed of 2 ounces of corrosive sublimate, 2 ounces of fine salt, 8 ounces of powdered borax, and 1½ drams of aniline red was added to each jar. Other composite samples were made by taking one tenth of a quart each day, but these received no preservative. The milk in these latter samples became sour and curdled. It was found that by adding about a half teaspoonful of "powdered lye" (98 per cent caustic soda) to the sour milk it became "as thin and homogeneous as new milk" and could be accurately sampled.

The action of the lye on sour milk is hastened by adding it to the milk in small quantities so that the lye is dissolved. If one half a teaspoonful of the lye is thrown into the milk at once, it collects together in a hard lump, which is dissolved with difficulty. The whole process of thinning the thick sour milk with lye is aided by warming the milk at a temperature of 100° to 140° F., and letting it stand for an hour or more. The time and heat both help the solvent action. Pouring from one jar to another is also an important factor in getting the milk thoroughly mixed.

The results are given for the tests made each day, with the averages of these for the 7 days, and for the three sets of composite samples. The following comparison of the results by the different methods of sampling is taken from the bulletin:

Average percentage of fat in milk by different methods of sampling.

Patron.	Average of the seven daily tests.	Composite samples.		
		Equal amounts of milk each day, poisoned.	Amounts proportional to the amount of milk brought, poisoned.	Equal amounts of milk each day, not poisoned.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
1	3.62	3.6	3.6	3.6
2	3.71	3.8	3.7	3.7
3	3.75	3.7	3.7	3.7
4	3.63	3.8	3.6	3.7
5	3.95	4.0	4.1	4.1
6	3.64	3.7	3.6	3.7
7	3.82	3.9	3.8	3.8
8	4.10	4.1	4.0	4.1
9	4.30	4.3	4.4	4.3
10	4.16	4.2	4.2	4.3
11	3.96	4.0	3.9	3.9
12	4.52	4.6	4.6	4.6
13	4.22	4.4	4.4	4.4
14	3.77	3.9	3.9	3.9
15	3.82	3.8	3.9	3.9
16	3.77	3.8	3.8	3.8
17	3.63	3.7	3.6	3.7
18	3.71	3.8	3.7	3.7
19	4.11	4.0	4.0	4.1
20	3.90	4.0	4.0	3.9

It will be seen that the agreement of the several series of composite samples is very close, and that these results present only slight variations from the averages obtained by testing samples daily. It would seem therefore that (1) "in this trial, testing the composite sample once each week was practically as accurate as testing milk every day;" and that (2) "it is not necessary to use a poison for preserving the milk, but that satisfactory results can be obtained by allowing the composite sample to sour, and thinning the sour milk by use of 'powdered lye' when a test is to be made." The results of the tests each day show considerable variations in the same milk from day to day, so that by taking a single sample of each patron's milk once a week sufficiently accurate results would not be obtained.

Trials in which the sample of milk was taken by different means, as by dipping, by the "milk thief," by a small tube, and by a small tube inside the delivery tube "indicate that there is practically no difference in the methods of taking a sample of milk for testing, if proper care is

used." Determinations made of the casein in samples of milk of each of five cows taken daily for 1 week, and in composite samples representing the same milk, showed a close agreement between the two methods of sampling.

An illustrated description of an automatic pipette for measuring the acid for milk tests, which was given in Bulletin No. 14 of the station, is reproduced here, together with a brief account of a stand for holding composite sample jars.

Application of the composite test to the dairy.—The milk of each of five cows was tested for 1 week, both by determining the fat daily and by testing the composite samples. In the latter no preservative was used, but instead lye was added at the time of testing. The results, which are fully tabulated, are an additional confirmation of the approximate accuracy of the method of determining the average percentage of fat by composite samples.

Kansas Station, Third Annual Report, 1890 (pp. 20).

This includes a financial statement for the fiscal year ending June 30, 1890, abstracts of Bulletins Nos. 10–19, an outline of the work of the station in 1890, and an index to the station publications for 1890.

Louisiana Stations, Bulletin No. 10 (Second Series), (pp. 55).

SYSTEMATIC FEEDING OF WORK STOCK AS A PREVENTIVE OF DISEASE, W. H. DALRYMPLE, M. R. C. V. S. (pp. 232–244).—A popular discussion of the effects of improper feeding on the health of horses and mules.

SOME DISEASES OF FARM ANIMALS, W. H. DALRYMPLE, M. R. C. V. S. (pp. 245–283).—Popular statements regarding the causes, symptoms, and treatment of the following diseases: *Swine.*—cholera, mange, inflammation of the lungs, trichinosis, and "measles;" *sheep.*—foot rot, liver rot, parasitic diseases of the lungs, grub in the head, mange, and gid; *cows.*—parturient apoplexy, abortion, and mammitis.

Massachusetts State Station, Eighth Annual Report, 1890 (pp. 324).

This includes the details of two feeding experiments with milch cows, two with pigs, and one with young lambs; numerous field experiments; report of the mycologist; analyses of feeding stuffs, licensed commercial fertilizers, fertilizing materials, water, etc.; a compilation of analyses of various materials; and meteorological observations. The chemical work during the year includes some 1,300 analyses, about 400 of which were made for the Massachusetts Hatch Station and from 300 to 400 at the special request of farmers of the State.

Feeding experiments with milch cows, C. A. Goessmann, Ph. D. (pp. 12–69).—"It was the main aim of our feeding experiments with milch cows during the years 1885–89 to test the relative feeding value of our current coarse fodder articles, such as English hay, rowen, fodder corn, corn stover, corn silage, and roots." Accounts of some of these experiments were given in the Annual Reports of the station for 1888 and 1889, and in Bulletins Nos. 32, 34, and 35 (see Experiment Station Bulletin No. 2, part I, p. 74, and Experiment Station Record, vol. I, pp. 77, 81, and 222, and vol. II, p. 572).

"During the past year we have changed the object of our feeding experiments with milch cows. Having made ourselves, as far as practicable, familiar with the feeding effect and general economical value of our current coarse home-raised fodder articles, it was decided to compare the feeding value of our prominent concentrated fodder articles (grains, brans, oil cakes, gluten meal, starch feed, etc.)."

(1) *New-process vs. old-process linseed meal* (pp. 15–39).—This was an experiment to compare the effects of like amounts of new and old-process linseed meal on the quantity, quality, and cost of the milk. The experiment was reported in somewhat less detail in Bulletin No. 38 of the station (see Experiment Station Record, vol. II, p. 277).

(2) *Green crops vs. English hay* (pp. 39–54).—This experiment was made with six grade cows in different stages of the milking period, to observe the effect of substituting green forage crops (vetch and oats or soja beans) for a part of the hay, the grain remaining unchanged. It lasted from July 12 to September 30, 1890. During this time the grain ration consisted of $3\frac{1}{4}$ pounds each of corn meal, wheat bran, and new-process linseed meal per animal daily, and the "full ration" of hay was about 20 pounds per animal.

About three fourths of the hay in the ration was substituted by a mixture of green vetch and oats in the first period (July 12–August 1), and by green soja beans in the second period (August 12–September 1), each of the green foods being fed *ad libitum*. In the third period (September 10–30) a full ration of rowen hay (about 20 pounds per animal) was given. The cutting of the vetch and oats and soja beans was commenced as they were beginning to bloom and continued until they were nearly mature, though the stems were succulent when last fed. They were cut into pieces 6 to 8 inches long for feeding. From 50 to 60 pounds of vetch and oats and from 40 to 60 pounds of soja beans were consumed per animal daily, "the quantity decreasing in all cases towards the maturing of the crop, on account of the gradual increase of solid matter in the crop."

The results, including the analyses of the milk, are tabulated for each cow separately, together with the analyses of the corn meal, new-process linseed meal, wheat bran, vetch and oats, and soja beans fed, with reference to both food and fertilizing constituents.

Although the individual cows differed somewhat from each other in

the amounts of food consumed and milk produced while on the same ration, the general effect of the different rations was similar in all cases, so that the results for the six cows may be averaged for each period. The following table shows the averages per animal during each of the three periods. In calculating the net cost of food, corn meal was valued at $24, wheat bran at $20, linseed meal at $26.50, hay at $15, green vetch and oats at $2.75, and green soja beans at $4.40 per ton, and 80 per cent of the value of the fertilizing ingredients of the food was deducted from the first cost.

Yield of milk and cost of food per animal.

	Net cost of food per animal.	Yield of milk per animal.	Net cost of food per quart of milk.	Average dry matter consumed. per quart of milk.
		Quarts.	*Cents.*	*Pounds.*
Period I. Grain, hay, and vetch and oats	$2.54	200.6	1.27	2.75
Period II. Grain, hay, and soja beans	3.06	212.5	1.39	2.76
Period III. Grain and rowen hay	2.98	197.4	1.51	2.86

The analyses of milk show no considerable changes in composition which can be attributed to the influence of the different rations. The cows all slightly increased in weight during the experiment. The table indicates only slight differences in the average milk yield in the dry matter consumed, and cost of food per quart of milk in the several periods. The results in general seem to be slightly better during the first period, and are favorable to the green-fodder crops as compared with rowen hay. They are similar to the results obtained in previous experiments with green vetch, Southern cowpeas, and serradella, and lead the author to "recommend very highly the raising of any of the stated new fodder crops, either alone or as mixed crops, for the purpose of increasing the fodder resources of the farm during summer and autumn. They may serve as green fodder as well as hay; most of them have a higher nutritive ratio than either English hay, corn fodder, or corn stover; they tend to improve the soil chemically and physically; they yield liberal returns, and are, as a rule, highly relished by cattle."

Creamery record of the station for 1889 and 1890 (pp. 54–69).—This is a record for 1889 and 1890 of amounts, kinds, and market values of the feeding stuffs fed, the fertilizing ingredients of the same, the average composition of the milk, the cost of producing cream per quart and per space, the amount received for the same from a coöperative creamery, the calculated value of skim milk with whole milk at 3 cents per quart, the analyses of cream and butter fat, and the fertilizing constituents of cream. The methods used at the station in the analysis of dairy products are fully described. The feeding stuffs given consisted of the ordinary grain feeds, hay, corn fodder, stover and silage, roots, and numerous green fodders. The following statements are from the author's conclusions:

Total cost of food for 1 quart of cream amounted in 1889 to 11.09 cents, and in 1890 to 13.75 cents.

The net cost of food per quart of cream averaged in 1889, 6.9 cents, and in 1890, 6.05 cents. We received per quart of cream in 1889, 11.69 cents, and in 1890, 11.46 cents, thereby securing a profit of 4.79 cents in 1889, and 5.41 cents in 1890.

FEEDING EXPERIMENTS WITH LAMBS, C. A. GOESSMANN, PH. D. (pp. 70–90).—This is a more detailed account of an experiment reported in Bulletin No. 37 of the station (see Experiment Station Record, vol. II, p. 231).

FEEDING EXPERIMENTS WITH YOUNG PIGS, C. A. GOESSMANN, PH. D. (pp. 91–112).—When experiments in pig feeding were commenced in 1884, the question proposed for study was as to the most profitable utilization of skim milk and buttermilk. In the experiments on this subject two conditions have been considered, (1) a large supply of either skim milk or buttermilk, and (2) a limited one.

In considering the first condition, the plan has been to mix corn meal with the skim milk or buttermilk in the following proportions:

Live weight of animal:

20 to 70 pounds	2 ounces corn meal per quart of milk.
70 to 130 pounds	4 ounces corn meal per quart of milk.
130 to 200 pounds	6 ounces corn meal per quart of milk.

Where the supply of buttermilk and skim milk has been limited, the milk has been supplemented by the following grain mixtures extended with water:

Live weight of animal.	Grain mixture (parts by weight).		
	Gluten meal.	Wheat bran.	Corn meal.
20 to 70 pounds	2	1	....
70 to 130 pounds	1	1	1
130 to 200 pounds	1	1	2

The aim has been under both conditions to feed rations having the following nutritive ratios: With pigs weighing from 20 to 70 pounds, 1:2.8 to 1:3; with those weighing from 70 to 130 pounds, 1:3.6 to 1:4; and with those weighing from 130 to 200 pounds, 1:4.5 to 1:5.

From May, 1884, to September, 1889, ten separate experiments were made, in which 57 pigs were used. The average results of each of these experiments are given in the following summary, which is taken from the report. The pecuniary results are calculated on the basis of corn meal at $24, barley meal at $30, corn-and-cob meal at $20.70, and wheat bran and gluten meal each at $22.50 per ton; buttermilk at 1.37 cents, and skim milk at 1.8 cents per gallon; and by deducting 70 per cent of the estimated value of the fertilizing ingredients of the food to determine the net cost.

Results of ten feeding experiments with pigs (1884–89).

Experiment.	Number of pigs.	Average weight of pigs at beginning of experiment.	Average weight of pigs at close of experiment.	Articles of fodder used.	Total cost of food per pound of dressed pork.	Net cost of food per pound of dressed pork.
		Pounds.	*Pounds.*		*Cents.*	*Cents.*
I. May 21 to Sept. 22, 1884. a	3	48.8	239.0	Skim milk, corn meal	5.15	3.45
b	3	47.6	253.9	Buttermilk, corn meal	4.30	2.92
II. Nov. 5, 1884, to Mar. 21, 1885. a	6	30.1	209.7	......do	5.91	4.11
b	6	28.7	227.0	Skim milk, corn meal	5.51	3.82
III. April to Sept. 16, 1885	2	49.8	279.3	Skim milk, corn meal; Wheat bran, gluten meal	6.41	4.40
IV. Dec. 8, 1885, to May 31, 1886.	2	32.9	152.4	Skim milk, corn meal; Wheat bran, gluten meal	6.33	4.20
V. Sept. 15, 1886, to Jan. 19, 1887.	4	32.6	175.0	Skim milk, corn meal; Wheat bran, gluten meal	5.40	3.38
VI. Feb. 17 to May 2, 1887	5	54.4	152.8	Skim milk, corn meal; Wheat bran, gluten meal	5.69	3.74
VII. June 28 to Oct. 26, 1887	7	24.5	193.3	Skim milk, corn meal; Wheat bran, gluten meal	5.15	3.39
VIII. Nov. 8, 1887, to Mar. 12, 1888.	6	25.2	186.4	Skim milk, corn meal; Wheat bran, gluten meal; Corn-and-cob meal	5.32	3.58
IX. Apr. 12 to Aug. 8, 1888	6	19.6	194.7	Skim milk, corn meal; Wheat bran, gluten meal; Corn-and-cob meal	4.89	3.27
X. Apr. 26 to Aug. 28, 1889	7	20.3	189.9	Skim milk, barley meal; Wheat bran, gluten meal	6.07	4.32

The conclusions drawn from these experiments are the same as those stated in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 578).

Eleventh feeding experiment with pigs (pp. 95–105).—This experiment was made with five Yorkshire sows, weighing from 18½ to 21 pounds each at the beginning of the trial, and lasted from September 10, 1889, to March 3, 1890—175 days. The pigs were all fed alike. Each animal received daily 5 quarts of skim milk, except during the first 10 days of the trial, when only 4 quarts were given. The grain added to this milk was as follows: September 10 to 30, 2 ounces of corn meal per quart of milk; October 1 to November 11, 6 ounces of a mixture of 1 part by weight of wheat bran and 2 parts of gluten meal, which was increased with the increasing weight of the pig to from 30 to 36 ounces at the close of the period, when the pigs weighed from 85 to 95 pounds each; November 12 to December 30 a mixture of 4 parts by weight of corn meal and 1 each of wheat bran and gluten meal, of which 32 to 36 ounces per pig were given daily at the beginning of the period, and 42 to 45 ounces at the close, at which time the pigs averaged about 130 pounds each; and December 31 to March 3, a less nitrogenous mixture, composed of 6 parts by weight of corn meal, and 1 each of wheat bran and gluten meal, of which about 48 ounces per day were fed toward the close of the trial.

The nutritive ratio of the rations was thus, with a live weight of 20 to 90 pounds (September 10 to November 11), 1:3; with a live weight of 90 to 130 pounds (November 11 to December 30), 1:3.8; and with a

live weight of 130 to about 200 pounds (December 30 to March 3), 1:4.25.

Full tabulated data are given for each pig, together with analyses of the skim milk and gluten meal, and the fertilizing ingredients of the corn meal, wheat bran, gluten meal, and skim milk which were fed. A summary of the results follows:

Results of eleventh feeding experiment with pigs.

	Total cost of food consumed.	Live weight gained during experiment.	Dressed weight gained during experiment.	Cost of food per pound of dressed weight.	Net cost of food per pound of dressed pork.*
		Pounds.	*Pounds.*	*Cents.*	*Cents.*
Pig No. 1	$7.58	167.00	138.50	5.47	3.49
Pig No. 2	8.02	178.25	147.75	5.43	3.45
Pig No. 3	8.19	174.75	146.75	5.58	3.60
Pig No. 4	7.69	162.75	134.50	5.72	3.74
Pig No. 5	7.54	160.75	135.25	5.57	3.59

* Total cost of food less 70 per cent of the estimated value of the fertilizing ingredients.

The average net cost of food per pound of dressed pork was 3.57 cents. The pecuniary results are based on corn meal at $19, wheat bran at $16.50, and gluten meal at $23 per ton, and skim milk at 1.8 cents per gallon.

Twelfth feeding experiment with pigs (pp. 106–112).—Eight pigs, four Yorkshires and four grade Chester Whites, were fed from April 22 to September 1, 1890, practically the same rations as those in the preceding experiment, except that corn-and-cob meal was fed in place of the corn meal. The details are tabulated in full, together with analyses of the corn-and-cob meal fed, and the fertilizing ingredients in the corn-and-cob meal, wheat bran, gluten meal, and skim milk.

The four Yorkshires gained 473.04 pounds of dressed weight at a cost per pound of 3.61 cents, and the four grade Chester Whites 484.62 pounds of dressed weight at a cost per pound of 3.49 cents.

FODDER ANALYSES, C. A. GOESSMANN, PH. D. (pp. 113–134).—Analyses made during the year 1890 are given of the following feeding stuffs: Corn meal, corn-and-cob meal, wheat bran, wheat shorts, wheat middlings, buckwheat middlings, old and new-process linseed meal, cotton-seed meal, gluten meal, seed of Scotch tares, corn fodder, corn stover, corn silage, soja bean and cowpea silage, vetch and oats, Royal English Horse and Cattle Condiment, and Harvey's Universal Vegetable Food; the fertilizing ingredients of old and new-process linseed meal, cotton-seed meal, gluten meal, corn fodder, soja bean and cowpea silage, vetch and oats, and seed of Scotch tares. There is also a description of the methods employed in the analysis of feeding stuffs.

FIELD EXPERIMENTS, C. A. GOESSMANN, PH. D. (pp. 135–199).

Some suggestions on the economical improvement of farm lands (pp. 135–148).—A reprint from Bulletin No. 36 of the station (see Experiment Station Record, vol. II, p. 56).

Effect of different forms of nitrogenous fertilizers on oats (pp. 149–158).—Eleven tenth-acre plats, the history of which was well known, each received a quantity of muriate of potash or potash-magnesia sulphate furnishing 12 to 13 pounds of potassium oxide, and of dissolved boneblack furnishing 8.5 pounds available phosphoric acid. In addition to this from 4 to 5 pounds of nitrogen as nitrate of soda or sulphate of ammonia, or 5 to 6 pounds as dried blood were applied on seven plats, the remaining four plats receiving no nitrogen. One plat received barnyard manure, potash-magnesia sulphate, and dissolved boneblack, furnishing approximately the same amounts of nitrogen, phosphoric acid, and potash as the other plats received. The fertilizer applied to each plat was the same in kind and amount as that applied for corn the preceding year.

The oats (Pringle Progress) were sown in rows 2 feet apart, each plat containing sixteen rows. Quite marked differences were noticed in the color of the plants on the different plats. "Upon plats which had received their nitrogen in the form of sulphate of ammonia, as well as upon those which had received no nitrogen-containing manurial matter, a light green tint of the foliage was noticed in the earlier stages of the growth of the oats. In the latter case this light green color remained until the maturing began: in the former case (sulphate of ammonia) the color became a deeper green as the season progressed." The crop was harvested August 11. The yields of grain and straw and the dry matter and fertilizing ingredients in the grain from each plat are tabulated. Excluding one plat, which was a failure, the yield of grain was smallest on the three plats receiving no nitrogen. "The plats containing potash-magnesia sulphate as the potash source yielded the largest amount of grain: each of these plats received its nitrogen supply in a different form—ammonium sulphate, blood, and nitrate of soda. * * * In the majority of cases where muriate of potash has furnished the potash the maturing of the crop was somewhat later than where sulphate of potash was used."

Influence of fertilizers on the quantity and quality of prominent fodder crops (pp. 159–168).—A report of progress on an experiment begun in 1884. Previous accounts may be found in the annual reports of the station (see Experiment Station Bulletin No. 2, part I, p. 86, and Experiment Station Record, vol. II, p. 580). In 1890 all the plats used in this experiment were fertilized with 600 pounds of ground bone and 200 pounds of muriate of potash per acre. Notes are given on the growth and yield of Kentucky blue grass (*Poa pratensis*), redtop (*Agrostis vulgaris*), Bokhara clover (*Melilotus alba*), sainfoin (*Onobrychis sativa*), Rhode Island bent grass (*Agrostis alba*), meadow fescue (*Festuca pratensis*), and herd's grass (*Phleum pratense*), and of mixtures of redtop with herd's grass and meadow fescue with herd's grass. Analyses with reference to both the food and fertilizing constituents are reported for meadow fescue, Kentucky blue grass, alsike clover, medium clover, sweet clover, and sainfoin grown in 1889 and 1890.

Experiments with field and garden crops (pp. 169–186, plates 2).—These were in continuation of experiments reported in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 580). Notes are given on the growth and yield of barley, perennial rye grass (*Lolium perenne*), Early Southern White corn, horse bean (*Vicia faba*), soja beans (*Soja hispida*), Scotch tares, common vetch (*Vicia sativa*), white lupine (*Lupinus alba*), serradella (*Ornithopus sativus*), Bokhara clover, (*Melilotus alba*) sainfoin (*Onobrychis sativa*), sulla (*Hedysarum coronaria*), *Lotus villosus*, sugar beets, flax, and Danvers carrots.

Analyses with reference to both the food and fertilizing constituents are reported for *Lotus villosus*, sulla, teosinte, Japanese buckwheat, small peas (*Lathyrus sativus*), Scotch tares, carrots, parsnips, barley straw, Bokhara clover, soja beans, and turnips. Analyses of samples of five varieties of sugar beets grown on the station grounds gave percentages of sugar in the juice ranging from 12.75 to 14.30.

Effects of phosphoric acid from different sources on potatoes (pp. 187–191).—The object of this experiment was to test the relative effects of like money values of phosphatic slag, Mona Island guano, apatite, South Carolina phosphate (floats), and dissolved boneblack for potatoes. The land used (a fair sandy loam) had been prepared for the experiment by cropping for the 3 previous years with corn, Hungarian grass, and leguminous crops, respectively, without applying fertilizers. It contained five plats, approximately one seventh of an acre each, separated from each other by strips 8 feet wide. All the plats received the same amount of potash-magnesia sulphate and nitrate of soda. The source of phosphoric acid was different on each plat, an amount being applied in each case which at the local market prices cost $6.25 per acre. Thus phosphatic slag, Mona Island guano, and South Carolina rock were each applied at the rate of 850 pounds per acre, dissolved boneblack at the rate of 500 pounds, and apatite at the rate of 2,000 pounds. Beauty of Hebron potatoes were planted on all the plats, in rows 3¼ feet apart, with the hills 18 inches apart in the rows.

Maturity seemed to have been hastened by a drouth occurring in July. The potatoes were harvested August 12–14, and assorted into marketable (sold at 60 cents per bushel) and small (sold at 20 cents). The yield and financial statement for each plat and analyses of the phosphates used are tabulated. A statement of the yield and value per acre follows:

Yield and value of potatoes per acre.

Source of phosphoric acid.	Yield of— Large potatoes.	Yield of— Small potatoes.	Total value of crop.
	Bushels.	*Bushels.*	
Phosphatic slag	134.6	43.0	$89.36
Mona Island guano	101.2	55.3	71.78
Ground apatite	117.1	47.1	79.68
South Carolina phosphate	149.3	48.7	99.32
Dissolved boneblack	170.3	56.8	113.54

"The dryness of the season renders the advantages of a soluble form of phosphoric acid very striking. The experiment will be repeated during the coming season."

Experiments with grass land (pp. 192–198).—An account is given of the improvement of a low, springy meadow by underdraining and seeding down with grass mixtures, and a report of the subsequent manuring of the land and the yields of hay from portions receiving different treatment in 1889 and 1890.

From "an unsightly, swampy meadow, covered with a comparatively worthless vegetation," the land has been brought up in 4 or 5 years to a yield of from 3 to 4$\frac{3}{4}$ tons of good hay per acre.

General farm work (p. 199).—Remarks regarding the current farm work. "A new orchard, covering an area of from 6 to 7 acres, has been in part planted with apple, pear, peach, and plum trees; other varieties, as well as small fruits, will be planted during the coming spring."

REPORT OF VEGETABLE PATHOLOGIST, J. E. HUMPHREY, B. S. (pp. 200–226, plates 2).—This includes notes on the black knot of the plum, cucumber mildew, brown rot of stone fruits, potato scab, and various other plant diseases.

Black knot of the plum (pp. 200–210).—Brief account of the history of investigations of black knot of the plum (*Plowrightia morbosa*), and preliminary notes on observations by the author on the spore forms of this disease. A pycnidial form not previously observed is described and illustrated. Of the four kinds of spore fruits described by Dr. Farlow, the author has observed those producing ascospores and what seem to be second forms of pycnidia. The spermogonia and stylospores (*Hendersonula morbosa*, Sacc.) have not been found as yet.

Cucumber mildew (210–212).—The form of cucumber mildew first observed in this country in 1889, and hitherto known as *Peronospora cubensis*, was found on cucumbers and squashes in Massachusetts in 1890. This species and *P. australis*, found on the wild star cucumber, are compared and illustrated. The haustoria of both species are of the small, knoblike type. Those of *P. cubensis* are scattered over the yellow and dead-looking spots on the leaf and "do not form a close felt, visible to the naked eye." *P. australis*, on the contrary, forms dense white tufts, of small extent, on the leaves of the star cucumber. The structure of the spore-bearing threads in the two species is strikingly different.

Correlated with the development of small haustoria is frequently found, as in the grapevine mildew and in *P. australis*, a pinnate branching of the conidial threads, and conidia with an apical papilla, which germinate by producing zoöspores instead of a tube. In *P. cubensis* we have the anomaly of conidial threads which follow the type of branching usually seen in the species with branched haustoria, and conidia of a violet tint, such as are almost unknown except among the latter group, while the haustoria are small and the conidia have the apical papilla and produce zoöspores on germination. This species goes far to break down the distinctions held by some writers to exist between the two groups which constitute the genera *Plasmopara* and

Peronospora of recent writers, though all were formerly included in *Peronospora*. If the distinction is to be maintained on the basis of the germination of the conidia, we must then call these two fungi *Plasmopara australia*, Speg., and *Plasmopara cubensis*, B. and C. The formation of resting spores has not been observed in either species, yet it is evident that they have some means of surviving the winter.

Brown rot of stone fruits (pp. 213–216).—Observations by the author are cited which indicate that *Monilia fructigena* survives the winter through the formation of resting cells or gemmæ, and that, "whatever its origin, any other forms once connected with it have been lost, and it is therefore fairly safe to regard it as an autonomous fungus."

Potato scab (pp. 216–220).—Experiments along the lines suggested by those recorded in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 580) were continued in 1890. Of 13 varieties of potatoes tested in 1890 Rough Diamond was the only one which showed no scab, though Rural New Yorker and White Seedling were comparatively free from it. The plowing in of winter rye on half of each plat produced no perceptible effect on the amount of scab. The results from deep *vs.* shallow planting in 1890 do not bear out the opinion doubtfully expressed in 1889, that deep planting diminishes scab. The free use of coal ashes in the drill produced no observable effect on the development of scab. "The thicker-skinned and red-skinned varieties showed no greater resistance to scab than others; our best results in 1890 were from light-skinned and rather delicate fine-grained sorts." The results of investigations into the cause of scab by H. L. Bolley (see *Agricultural Science*, September and October, 1890) and by R. Thaxter, as given in Bulletin No. 105 of the Connecticut State Station (see Experiment Station Record, vol. II, p. 490), are briefly discussed. The author finds it difficult to believe that the "deep" and "surface" forms of scab are entirely distinct.

Miscellaneous notes (pp. 220–226).—(1) *Damping off of cucumbers.*—Observations by the author indicated that this affection is caused by the fungus *Pythium de baryanum*, Hesse, which is known to produce the same effect in Europe. On the assumption that this fungus is always the cause of the trouble, "plants affected should be at once removed, with the soil immediately surrounding them, and burned. If this is done as soon as the seedling falls, the trouble can be held in check, since the fungus will be destroyed before its reproductive organs have developed."

(2) Brief notes are also given on the mildew of spinach (*Peronospora effusa*), grapevine mildew (*Plasmopara viticola*) observed on *Ampelopsis veitchii*, downy mildew (*Peronospora parasitica*) and white rust (*Cystopus candidus*) on turnips, potato rot (*Phytophthora infestans*), elder rust (*Æcidium sambuci*), rust of blackberries and raspberries (*Cæoma nitens*), hollyhock rust (*Puccinia malvacearum*), and an undetermined disease of oats.

Special work in chemical laboratory (pp. 227–312).—This includes the work done by the station during the year in the inspection of commercial fertilizers, analyses of wood ashes, cotton-hull ashes,

saltpeter waste, refuse from glue factory, fish chum, dry ground fish, blood, bone and meat, ground bone, bones boiled in potash, starch waste, "sludge" from Worcester sewage-precipitating tanks, tankage, Florida phosphate rock, dissolved boneblack, German phosphatic slag, hen manure, jute waste, shelled corn, buckwheat hulls, seaweed, residuum from soft coal, vegetable ivory, Concentrated Flower Food, Flora Vita, compound fertilizers, Paris green, Sulphatine, Death to Rose Bugs, Professor De Graff's Bug Destroyer, tobacco liquid, and 65 samples of well water, and a compilation of analyses of agricultural chemicals and refuse materials used for fertilizing purposes, feeding stuffs, fruits, sugar-producing plants, dairy products, etc.

Commercial fertilizers (pp. 228–258).—General remarks on commercial fertilizers and their inspection, the trade values of fertilizing ingredients for 1890, the text of the Massachusetts fertilizer law, list of licensed dealers, and analyses of 158 commercial fertilizers, including bones, sulphate of ammonia, sulphate of potash, muriate of potash, and nitrate of soda. Of the 158 samples analyzed, 54 were below the guaranty in one ingredient, 10 in two ingredients, and 3 in all three ingredients; 56 were above the guaranty in one ingredient, 30 in two ingredients, and 4 in all three ingredients. "The deficiency in regard to one or two essential constituents was in the majority of cases commercially compensated by the excess of another one."

METEOROLOGY (pp. 313–316).—Brief notes on the weather and a summary of meteorological observations for each month of 1890.

REPORT OF TREASURER, F. E. PAIGE (p. 317).—This is for the year ending December 31, 1890, and contains a summary of the property of the station, in addition to a statement of receipts and expenditures.

Massachusetts State Station, Bulletin No. 40, July, 1891 (pp. 16).

METEOROLOGICAL SUMMARY (p. 1).—This is for the months of March to June, 1891, inclusive.

SOME DISEASES OF LETTUCE AND CUCUMBERS, J. E. HUMPHREY, B. S. (pp. 2, 3).—A brief announcement of observations on a species of *Botrytis* or *Polyactis* as the cause of lettuce rot, and on the powdery mildew of the cucumber (*Oidium erysiphoides*, Fries, var. *cucurbitarum*). Details will be published in the Annual Report of the station for 1891.

FERTILIZERS, C. A. GOESSMANN, PH. D. (pp. 4–6).—Analyses of 16 samples of commercial fertilizers and 5 samples of bone, and the trade values of fertilizing ingredients for 1891.

FEEDING EXPERIMENTS WITH STEERS, C. A. GOESSMANN, PH. D. (pp. 7–16).—"With a view to determining the cost of the food required for the production of beef under existing local conditions," an experiment, the first of a series, was made during the winter of 1889–90 with two yearling and two 2 year-old grade Shorthorn steers. Two different ages were taken to observe the difference in the cost of the gain as the

animals grew older. The steers were all fed definite quantities of the grain rations, consisting at different times of wheat bran, with gluten meal or old-process linseed meal, or with linseed meal and corn-and-cob meal, and coarse fodders consisting of corn stover, corn silage, corn fodder, or stover and sugar beets, *ad libitum*. The only essential difference between the food of the older and younger animals was in regard to the quantity and proportion of the constituents of the grain rations. The yearlings were fed from December 17, 1889, to May 9, 1890 (20 weeks) and the 2-year-olds from December 10, 1889, to March 25, 1890 (15 weeks). Full tabulated data with reference to food consumed, gain in live weight, cost of rations, cost of food per pound of gain, etc., are given for each animal, together with the fertilizing ingredients in each of the feeding stuffs used. In estimating the cost of food, wheat bran and corn-and-cob meal are each reckoned at $16.50; gluten meal at $23; old-process linseed meal at $27.50; corn stover and sugar beets each at $5; corn fodder at $7.50, and silage at $2.75 per ton, allowing 8 per cent for the loss of fertilizing ingredients of the food. "The net cost of the food, therefore, represents the cost of the food consumed after deducting from its original market price 92 per cent of the money value of the essential fertilizing constituents—nitrogen, phosphoric acid, and potassium oxide—it contains."

A tabulated summary of the results for the whole experiment follows:

Summary of results of feeding steers.

	Live weight at beginning of experiment.	Gain in live weight.	Dry matter consumed per pound of gain.	Total cost of food consumed.	Total value of fertilizing ingredients in food.	Net cost of food per pound of gain.*
	Pounds.	*Pounds.*	*Pounds.*			*Cents.*
Yearlings: No. 1	675	220	8.91	$16.92	$11.35	2.95
No. 2	600	240	8.78	17.52	11.82	2.77
2-year-olds: No. 3	1,235	135	17.19	16.37	11.26	4.45
No. 4	1,180	120	17.32	15.31	10.40	4.78

*Allowing a loss of 8 per cent of the manurial value of the food.

Corn silage, when fed either with wheat bran and gluten meal or with wheat bran and old-process linseed meal, produced the highest gain in live weight without exception. The increase in live weight when feeding the silage ration to 1-year-old steers, in one instance, exceeded 3 pounds per day; while in the case of 2-year-old steers it averaged more than 4 pounds per day in one case.

The original cost of the food consumed per day on the silage ration was from 12.82 to 14.72 cents in the case of 1-year-old steers, and from 16.67 to 19.33 cents in the case of 2-year-old steers; and the net cost of the food per day was from 4.81 to 5.26 cents in the case of 1-year-old steers, and from 6.65 to 7.11 cents in the case of 2-year-old steers.

While on the silage ration the daily increase in live weight averaged 2.9 pounds for the yearlings and 3.45 for the 2-year-olds. The first cost of the food during this time averaged 4.8 cents per pound of gain for the younger animals and 5.22 cents for the older, while the net cost averaged 1.82 cents for the yearlings and 2.08 cents for the 2-year-olds.

The two yearlings were pastured from May 10 until September 30 at a cost of 40 cents each per week. Steer No. 1 gained 125 pounds and No. 2, 83 pounds in live weight, at which rate the cost per pound of gain would be 6.58 cents for No. 1 and 9.91 cents for No. 2.

Massachusetts Hatch Station, Bulletin No. 14, May, 1891 (pp. 62).

Soil tests with fertilizers, W. P. Brooks, B. S.—A report of 13 coöperative experiments with corn made in 1890 in ten different counties of the State. As in the experiments of 1889, reported in Bulletin No. 9 of the station (see Experiment Station Record, vol. II, p. 233), the plan followed was that adopted by the conference of experiment station representatives at Washington in March, 1891, and published in Circular No. 7 of this Office.

Fifteen twentieth-acre plats were used in each of the experiments except one. These plats were separated by intervening strips, making the total area 1 acre. The soils represented were mostly loams, ranging from light sandy to clayey loam. As indicated by the yields of the unfertilized plats, they were in general quite even in fertility, being in this respect better adapted for experimenting than many of those used in 1889. Nitrate of soda at the rate of 160 pounds per acre, dissolved boneblack at the rate of 320 pounds, and muriate of potash at the rate of 160 pounds were used singly, two by two, and all three together on seven plats; land plaster 160 pounds, lime 160 pounds, and barnyard manure 5 cords per acre were each used on one plat, and 5 plats received no application. The analyses of these materials are given. The fertilizing materials were in all cases applied broadcast upon the plowed land and harrowed in just before planting. The corn was planted in rows 3½ feet apart, and, with one or two exceptions, in hills. The selection of the variety was left to the individual experimenter, but in most cases a yellow flint variety was used. The fertilizers, except the barnyard manure, were supplied by the station. Each experimenter was also furnished with maximum and minimum registering thermometers and a rain gauge. In nearly every case the work was carried out according to the directions given.

Each experiment was inspected twice during the season by representatives from the station, and the harvesting and weighing of the crops were done in the presence of an assistant.

Each of the thirteen experiments, including two made at the station, is reported by itself, and details are given in each case with reference to the fertilizers applied; the yield of corn and stover per acre; the gain or loss compared with the unfertilized plats; the result of measurements made during the growing season; the calculated results of the addition of nitrogen, phosphoric acid, potash, complete fertilizer, barnyard manure, land plaster, and lime; the financial results; summary of the weather observations; and analyses of the barnyard manure used. In

several instances the same land was used as in 1889, and in these cases the results of 1890 often strengthened the conclusions reached in the preceding year.

The results of each experiment are discussed at considerable length and in most cases practical suggestions are made as to the treatment of the soil likely to give the most profitable results. The following are among the author's conclusions from the experiments:

(1) Our results show that soils differ widely in their requirements.

(2) Potash, however, much more often proves beneficial or proves much more largely beneficial than either nitrogen or phosphoric acid.

(3) Potash as a rule most largely increases the yield of both grain and stover, but its effect upon stover production is greater than upon grain production.

(4) Barnyard manures are as a rule relatively deficient in potash, probably because of the loss of a large proportion of the urine, which contains about four fifths of the total potash of the excretions. * * *

(5) The relative deficiency of potash in so many soils, shown now by the results of the work of two seasons, I believe justifies the following general advice:

In breaking up sod lands for corn, particularly that which is in fair condition but which has been under ordinary farm management, if fertilizers only are to be used apply those which are rich in potash. Use materials which will supply 80 to 100 pounds of actual potash, from 25 to 30 pounds of phosphoric acid, and from 15 to 20 pounds of nitrogen per acre.

If a special corn fertilizer is to be used, apply only a moderate quantity, say 400 to 500 pounds per acre, and use with it about 125 pounds of muriate of potash. It is believed this combination will produce as good a crop as 800 to 1,000 pounds of "corn fertilizer," and it will cost considerably less.

With ordinary barnyard or stable manure for corn use potash. I would recommend using about 4 cords of manure and 100 pounds of muriate of potash per acre.

For fodder or silage corn use, either in fertilizers or with manures, about one fourth more potash than above recommended.

In our experiments all fertilizers and manures have been applied broadcast and harrowed in, and I believe this is the best method.

Formulas based on the results of these experiments are given for five different fertilizing mixtures for corn.

Brief mention is made of an experiment at the station with fertilizers for potatoes, in which the arrangement of the plats and the kinds and quantities of fertilizers used were the same as in the corn experiment described above. The detailed records of this experiment were destroyed by fire, but the author states that "no plat gave an entirely satisfactory crop. The barnyard manure gave the largest yield, but not of the best quality. Quantity and quality considered, the complete fertilizer gave the most satisfactory results, but not the most profitable. Potash for this crop, as for corn, seemed to be most deficient in this soil."

Massachusetts Hatch Station, Meteorological Bulletin No 31, July, 1891 (pp. 4).

A daily and monthly summary of observations for July at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

Mississippi Station, Bulletin No. 15, June, 1891 (pp. 16).

FEEDING, E. R. LLOYD, M. S. (pp. 2–4).—*Feeding experiments with milch cows.*—"To determine the relative values of different foods for the production of milk and butter" six lots of 5 cows each (4 grade Jerseys and 1 grade Holstein) were fed the following rations per animal daily during 5 weeks, the first week being regarded as preliminary:

Lot 1, 9.2 pounds Bermuda hay + 9.5 pounds raw cotton seed.
Lot 2, 10.5 pounds Bermuda hay + 10.6 pounds roasted cotton seed.
Lot 3, 8.5 pounds Bermuda hay + 10.4 pounds steamed cotton seed.
Lot 4, 9.9 pounds Bermuda hay + 9.9 pounds corn meal.
Lot 5, 8.5 pounds timothy hay + 9.5 pounds raw cotton seed.
Lot 6, 10.9 pounds Bermuda hay + 9.5 pounds cotton-seed meal.

"The cows in the different lots averaged as nearly as possible the same length of time from calving, and the yield of each lot did not vary more than 2 pounds from any other lot." The milk of each cow was weighed separately, and tests of the fat contained in the mixed milk of each lot were made morning and evening by the Babcock and Beimling methods. The tabulated data given include for each lot the gain in live weight, the production of milk and of butter fat (as calculated from the analyses of the milk), and the cost of the same. The financial results are based on timothy hay at $20.80, Bermuda hay at $12.50, raw cotton seed at $6, roasted cotton seed at $7.20, steamed cotton seed at $6.30, cotton-seed meal at $20, and corn meal at $25 per ton, making no allowance for the value of the manure.

According to the results as tabulated, lot 1, receiving Bermuda hay and raw cotton seed, produced butter and milk at the lowest cost.

This lot produced milk at a cost of 7.7 cents per gallon and butter at a cost of 17.4 cents per pound, but the butter was of poor quality, being sticky and of poor flavor. The most expensive milk and butter were from lot 4, which was fed on Bermuda hay and corn meal, the milk costing 12.8 cents per gallon and the butter 41.4 cents per pound. [This ration cost more than twice as much as that given lots 1 and 3, and was by far the most expensive ration fed.] The butter from this lot was of excellent quality, but not so good as that from lot 3, and cost more than twice as much. This lot also showed a loss of flesh of 34 pounds, while lot 3 gained 214 pounds.

As between Bermuda hay and timothy hay (lots 1 and 5) the results were in favor of the former. Lot 5 (timothy) "gained well in flesh, but produced only a small amount of milk." Based on the gross cost of the food, the milk produced by this lot cost 12.8 cents per gallon, and the butter 29.5 cents per pound, as compared with 7.7 cents and 17.4 cents where Bermuda hay and cotton seed were fed (lot 1). "Had the timothy cost the same as did the Bermuda hay, the cost would have been only 9.5 cents per gallon for the milk and 21.9 cents for the butter."

The author believes from the work done at the station up to the present time that in that section—

(1) For the production of milk a ration consisting of Lespedeza hay and raw cotton seed is the cheapest.

(2) For the production of butter a ration of Lespedeza or Bermuda hay and steamed cotton seed is the most profitable.

(3) When fed cotton seed, either raw, roasted, or steamed, cows will gain in flesh better than when fed corn meal or cotton-seed meal.

(4) Either Bermuda or Lespedeza hay is preferable to timothy hay.

(5) Corn meal is not an economical grain ration when fed with dry hay.

(6) Steamed [cotton] seed will produce better butter than will either raw or roasted seed.

Hay for working mules (p. 4).—An experiment in which three working mules were fed Bermuda hay and three others timothy hay *ad libitum* for 2 months, both lots receiving the same amount of corn, showed "practically no difference between the two rations."

COMPARATIVE TESTS OF MACHINES AND METHODS FOR THE DETERMINATION OF FAT IN MILK, L. G. PATTERSON (pp. 5–16, figs. 7).—A description is given of the Patrick brine-bath method, and the Babcock and Beimling centrifugal methods for determining the fat in milk, together with the results of comparative determinations by each of these methods and the Adams gravimetric method. Five tests by the Babcock method were spoiled by the belt becoming too loose. Of the 29 remaining tests by this method, the results of 9 differed from the gravimetric by 0.1 per cent or less, 8 by 0.2 per cent or over, and 2 by over 0.33 per cent, the largest difference being 0.38 per cent. Of 34 tests by the Beimling method 18 gave results differing from the gravimetric by 0.1 per cent or less, 4 by 0.2 per cent or over, and the greatest difference was 0.24 per cent. Twelve of the 17 tests made by the Patrick method differed from the gravimetric by 0.1 per cent or less, 2 by over 0.2 per cent, and the greatest difference was 0.27 per cent.

The following are the author's conclusions:

The Beimling method requires less time than does either of the others, but the scale on the bottles is not as easy to read and no means are provided for keeping the fat in a melted condition.

The Babcock has the best bottles, but requires more time for its operation, and it is absolutely necessary to have the specific gravity of the acid exactly 1.82.

The Patrick method is very convenient where a large number of tests are to be made, but it requires considerable time to heat the bath, and the bottles are very easily broken.

Missouri Station, Bulletin No. 15, July, 1891 (pp. 16).

TEST OF VARIETIES OF WHEAT AND OATS, H. J. WATERS (pp. 3–11).—Tabulated data are given for 13 varieties of wheat tested in 1889 and 55 in 1891, and for 11 of oats in 1889 and 13 in 1891.

In the test of varieties of wheat in 1889, Fultz led in yield and gave the smallest number of pounds of straw per bushel of grain; while in point of yield Red Chaff was second and Hybrid Mediterranean third. In 1891 the order was changed, giving Extra Early Oakley the lead with a yield of 42.5 bushels, while Willits followed with a yield of 39 bushels, and Coryell third, giving a crop of 36.9 bushels. In 1889

the main wheat crop, Fultz, in the same field with the varieties, gave a yield of over 35 bushels per acre, and in 1891 the remainder of the field where the varieties were grown yielded slightly over 30 bushels. From this it will be seen that our determination of yield per acre for a small area is not wide of the truth. There appears to be no direct relation between the proportion of straw down at harvest and the yield. Fultz gave a good though not the best yield. A further trial of the varieties leading in yield in 1891 will be necessary before their general adoption will be advisable.

In the comparative test of varieties of oats Pringle Progress gave the largest yield in both 1889 and 1891, though in weight per measured bushel it was among the lowest.

CHANGE OF SEED OF WHEAT, OATS, AND POTATOES, H. J. WATERS (pp. 11-16).—Descriptive notes and tabulated data for an experiment planned with reference to comparing the results of planting Northern and Southern-grown seed.

New Jersey Stations, Bulletin No. 81, July 1, 1891 (pp. 15).

INCOMPLETE FERTILIZERS AND HOME MIXTURES, E. B. VOORHEES, M. A.—Analyses are given of sixty-three samples of fertilizing materials, including nitrate of soda, sulphate of ammonia, dried blood, boneblack, bone ash, rock phosphates, muriate of potash, sulphate of potash, double sulphate of potash and magnesia, kainit, and home mixtures; the schedule of trade values adopted for 1891 by the New Jersey, Connecticut, and Massachusetts Stations; a table comparing the average cost of essential ingredients at the retail prices of the raw materials, with the station schedule; and formulas for home mixtures for general crops, for potatoes, and for peach trees. The comparison of the cost per pound of nitrogen, phosphoric acid, and potash at the prevailing retail prices of raw materials with the schedule of trade values adopted for 1891 revealed the fact that "the station's schedule agrees closely with the manufacturers' averages for nitrogen and potash, while in the case of available phosphoric acid the station's prices are over 20 per cent greater than the prices at which it has been bought by farmers direct from the manufacturers."

The analyses of the home mixtures, which had been made according to formulas furnished, showed a very close agreement between the percentage of ingredients as calculated from the formulas and that actually found in the mixtures.

The main objects of the analyses were to determine, (1) whether farmers, using the ordinary tools and labor of the farm, could make even mixtures of the materials used; and (2) whether in the cost of actual plant food, home mixing presented any advantages over the usual method of buying manufactured fertilizers. * * * The mixtures do contain practically the amount and proportion of plant food that they were intended to furnish, and therefore show that farmers are able to make even mixtures of such raw materials as the market affords.

[Concerning the pecuniary results] the station's valuation of the home mixtures is $2.92 greater than their cost. This represents the total saving only when the station's valuation of manufactured brands is equal to their selling price at the point of consumption.

New Jersey Stations, Bulletin No. 82, July 3, 1891 (pp. 40).

THE ROSE CHAFER, J. B. SMITH (figs. 10).—This is a popular account of observations and experiments by the author and his correspondents on the rose chafer (*Macrodactylus subspinosus*) during 1890 and 1891. Reference is made to earlier accounts of this insect by Harris and Fitch, and especially to an article by Riley published in Insect Life, vol. II, p. 295, from which two of the ten figures illustrating the bulletin are taken. The subjects treated are, history of the insect in New Jersey, food habits, mouth parts, habits of the beetle, date of appearance, egg-laying habits, the larva, breeding habits, life history, and remedies.

This insect has done more injury during the past few years than any one other species in the State of New Jersey, excepting perhaps the codling moth and plum curculio. * * * From all that I can learn, the present invasion dates back some 4 to 6 years, and has been gradually extending and increasing since that time, until the larger part of the grape-growing region of southern New Jersey is invaded. Rather more than 20 years ago there was a similar irruption, which lasted 4 or 5 years and then suddenly ceased. In the interval the species was common, as it is nearly all over the State, but did no injury that attracted general attention. * * *

It is a peculiar fact, for which I have no explanation, that some localities, often very small, are almost exempt, while all around suffer; and again, one spot may be totally destroyed and the other as completely exempt. One year a narrow road will limit their wanderings, another year sees as pread of many miles, unchecked by forests or streams. * * *

[Numerous kinds of plants are mentioned as serving for food for this insect.] Poppies were attractive and so was the foxglove—but those which ate of the latter ate no more. The plant is evidently poisonous to the beetle, as a circle of dead specimens around each indicated. There were few beetles on this plant, however, compared with those on more attractive food. This observation led to an experiment with digitalis, which was not as satisfactory as I had hoped.

[The mouth parts of the beetle are described and illustrated.]

The true mandibles are small, mostly soft, and only partly chitinized, but with a hard, rough space at the inner side of the base, which might be called a molar or grinder; above this is a piece furnished with a dense fringe of hair which looks as if it might serve as a brush, and outside of that we find a third piece bearing a little pointed blade at the tip, which we can term the piercer.

This might be considered sufficient for all practical purposes, but we find in addition a second pair of jaws, set at the side of the lower lip, and these are furnished with a broad, hardened, chitinous tip, set with six pointed teeth. The latter are, I believe, the instruments with which the food is cut, to be afterward ground between the molars of the mandibles.

The beetles are active only during the day and most active in bright sunshine, feeding most generally in the afternoon, when the day's flight is over. They are torpid at night and quiet in cold or wet weather, doing little or no feeding, and not moving about. In bright, warm weather they take long flights, and the air is full of moving insects. They then fly from their breeding grounds and seek favorable feeding places, lighting in swarms on attractive plants and remaining there if undisturbed. I am of the opinion that when a specimen once settles down on a food plant it does not leave it again until the food is exhausted, and this explains why vineyards are usually injured along the edges first. I have watched a marked pair feeding on the same rose 3 days in succession. In cold or wet weather the nearest food plant will be selected, and thus the spread from the breeding places is prevented in favorable seasons, such as that of 1891. * * *

[The date of appearance] varies somewhat with the season, and ranges in the Vineland region from May 19 to May 25; it does not differ much for the rest of south Jersey, though they are about a week or 10 days later in the New Brunswick region and farther north. * * *

During the season of 1890 I tried to get at the egg-laying habits of the species by watching the insects in the field; but though I made my examinations at all hours of the day, from sunrise to sunset, I never found them ovipositing, and got no definite results. Yet eggs were constantly decreasing in number, and in 1890 many that were examined June 13 had none remaining in the ovaries. * * *

In order to discover the mature egg and the egg-laying habits of the insects, a considerable number were collected, only those in copulation being taken, in order that the sexes should be equally represented. These were placed in a large jar filled to the depth of 5 inches with soil from the vineyards, in which the larvæ were found during the early part of the season. Plenty of food (roses) was added and the jar was set out doors to give as nearly natural conditions as was possible. Before night a considerable number began burrowing into the ground; sometimes the female only, sometimes male and female working together and keeping side by side. Some of the beetles went down about 3 inches only, others burrowed to the bottom of the jar. More than half of them made no effort to burrow at all and fed until evening. * * * About the middle of next day I removed all those on top of the ground and placed them in another jar, prepared in the same way and with fresh food. Next morning I found that nine specimens had made their way to the surface in jar No. 1, and others were noticed burrowing in jar No. 2. Those in jar No. 1 were acting in a dispirited manner, fed only in a half-hearted way, and about one half (females) were dead before night. These were examined and the ovaries were empty. Those still alive had not more than twelve eggs left in the ovaries—six in each.

Turned out the earth carefully and found several more beetles still under ground and making little effort to move. In these cases the ovaries of the females were empty or had only a very few immature eggs. The most careful search discovered only some six or eight eggs, although there must have been many in the jar. The difficulty was in the recognition of the difference between an egg and a coarse grain of sand. The egg is yellowish gray in color, oval, the skin quite tough and parchment-like, covered with dust, so that it was simply impossible to recognize it except by touch with a knife point. They are evidently laid singly and at depths of from 3 to 6 inches under ground. With the second jar my experience was the same as with the first. The insects that were still lively and ready to fly had all more than twelve eggs; but some of the others, which, though not lively, were still feeding, were entirely bare of eggs. It is probable, then, judging from this observation and from the observations made last year in the field, that at least two trips under ground for the purpose of ovipositing are made by the female, and that on each occasion she deposits not less than twelve eggs. How long an interval there is between journeys I can not say, but I watched one pair, recognizable by a coat of whitewash, for 3 days, during which time they had evidently not been under ground. It is also a question as to how long the insects will feed after emerging from the ground and before beginning to oviposit. Specimens taken from the ground May 25 showed the eggs in the ovaries very immature and scarcely more than separated in the tubes. Thirty-six, the normal number of eggs to each female, I found the rule from June 5 to 11. At that time, 2 weeks after their first appearance, egg laying was not yet general, but was beginning. A considerable number of holes under badly infested vines, more noticeable in the early morning, seemed to indicate burrows for egg-laying purposes. My experience in 1890, when I found many females with empty ovaries on June 14, indicates that egg laying probably begins about 10 to 14 days after the insects first emerge, and that 1 week at the utmost is the period required by a single female to get rid of her stock of eggs. In 1891, I found at Jamesburg, June 20, numerous specimens on ferns and bracken, some females with empty ovaries, some with twenty-four eggs. We may therefore assume rather less than 3 weeks as the normal period of life for a single insect, and as the

time of maturing the beetles extends over about 1 week, or at most 10 days, the normal 4 weeks of the rose-bug invasion is accounted for. The settlement of this question is not unimportant, for it shows that vigorous measures for the destruction of these pests, taken early in the season of their appearance, have a twofold advantage: They not only lessen or avert immediate injury, but they also prevent oviposition, and thus lessen the next season's brood.

[From observations in different localities the author concludes] that the whole of the sandy region of south Jersey is a vast breeding ground for the larvæ, that they are scattered everywhere—comparatively abundant in cultivated ground and in light meadow land, and rare in heavy or wet soil or in such as has a hard surface crust. * * * In such lands as are plowed and cultivated, or are dressed with potash salts or nitrate of soda, the larvæ will not mature. Cultivation is therefore one very important way of keeping these pests in check.

[The life history of the rose chafer is thus briefly stated:] The eggs are laid under ground, singly, from the 10th to the 25th of June or perhaps later. How long this state lasts we do not know, but probably from 12 to 20 days. The larva feeds on the roots of plants, preferably grass, in light soil, descends below frost line during winter, ascends early in spring, and in April or in early May changes to a pupa. This state lasts from 10 to 30 days according to weather, and then from May 19–27 the beetles begin to transform and emerge, about 3 weeks being the life of an individual insect.

In connection with the discussion of remedies to be used for this insect, the breathing apparatus is described and illustrated. Unsuccessful experiments are reported with London purple, copper mixtures, pyrethrum, kerosene emulsion, kerosene extract of pyrethrum, lime, tobacco, acetic acid, quassia, digitalis, corrosive sublimate, muriate of ammonia, cyanide of potassium, Odorless Bug Killer, sludgite or "zomonia," kainit, and alum. Experiments with hot water (125° F.) indicated that this is an effectual remedy, provided the practical difficulties in the way of the application of the water at the proper temperature can be overcome. The planting of *Spiræa* and of blackberries as a means of attracting the rose chafer from other plants the author thinks may be of advantage to a limited extent. His experience leads him to the conclusion "that mechanical means of destruction, supplemented by counter attractives, can be relied upon in ordinary seasons to protect vineyards from the rose chafer." Modifications of the ordinary collecting umbrellas are described and illustrated. The bagging of grapes to protect them from the rose chafer, as well as from rot, is recommended. No indications have been found that the rose chafer suffers from parasites.

The following are among the practical suggestions given in the bulletin:

Prevent the breeding of the insects on your own land. This can be done by using only the heaviest land for grass, and keeping just as little light land as possible in sod. As the insects pupate early in May a thorough cultivation of all the ground that can be cultivated will turn up and destroy a large proportion in this stage. Either late in fall or early in spring land should be plowed and top-dressed with kainit. Where light grass land is to be put into use, plowing at this time would be most effective in destroying the insects. Vineyards especially should be deeply and thoroughly cultivated in May to turn up and destroy pupæ. The cleaner the land is kept the fewer insects will come to maturity. A great point is gained if the enemy

must come from the outside and does not appear everywhere in the vineyard at one time. * * *

In setting out vineyards, make use of those varieties that bloom early or very late, and of the *labrusca* varieties select the earliest. Plant Clinton or other *riparia* varieties among the Concord or *labrusca*. * * *

Stimulate the vines by appropriate fertilizers to force the blossoms, and by inducing a heavy bloom get a surplus that will stand some thinning by insects without really shortening the desired crop.

While the danger is greatest a man should be sent through the vineyard at least twice a day (Sundays not excepted), say in the early morning and just after noon, to clear the vines of beetles, using one of the described collectors. * * *

Collecting should be continued at least once a day for 3 weeks (even if the insects do no further injury) to prevent egg laying.

North Carolina Station, Bulletin No. 75*c* (Meteorological Bulletins Nos. 17 and 18), April 28, 1891 (pp. 31).

Meteorological summary for North Carolina, February and March, 1891, H. B. Battle, Ph. D., and C. F. Von Herrmann.—Notes on the weather, and monthly summaries and tabulated daily record of meteorological observations by the North Carolina weather service. The bulletin is illustrated with maps of North Carolina, showing the isothermal lines and the total precipitation for different parts of the State.

North Carolina Station, Bulletin No. 76, March, 1891 (pp. 20).

Plant diseases and how to combat them, G. McCarthy, B. S. (figs. 13).—Brief general statements regarding fungous diseases of plants, formulas for various fungicides, illustrated descriptions of spraying apparatus, and popular accounts of the following diseases, with suggestions as to remedies: Black rot of grapes (*Læstadia bidwellii*), mildew of the grape (*Peronospora viticola*), anthracnose of the grape (*Sphaceloma ampelinum*), black knot (*Plowrightia morbosa*), peach rot (*Monilia fructigena*), apple scab (*Fusicladium dendriticum*), pear leaf blight (*Entomosporium maculatum*), pear fire blight, peach yellows, potato blight (*Phytophthora infestans*), rust of cereals (*Puccinia graminis*), smut of grain (*Tilletia fœtens* and *Ustilago segetum*), corn smut (*Ustilago Zeæ-mays*), and ergot (*Claviceps purpurea*).

North Carolina Station, Bulletin No. 77, May 1, 1891 (pp. 8).

Value of pea-vine manuring for wheat, J. R. Chamberlain, B. S. (plate 1).—A continuation of an experiment commenced in 1888 and reported in Bulletin No. 72 of the station (see Experiment Station Record, vol. II, p. 372). In 1888–89 seven twenty-fifth-acre plats were laid out so that one half of each plat was on land in which a crop of black cowpeas had been plowed, and the other half on land which

had lain idle during the summer, a space of 10 feet being left between the two halves. Fertilizers consisting of kainit, acid phosphate, and cotton-seed meal, used singly or all three together, were employed on five of the plats, the other two receiving no fertilizer. The plats were sown to wheat (a mixture of Faltz and Fulcaster) at the rate of $1\frac{1}{2}$ bushels per acre. The results showed an average increased yield of 10 bushels of wheat per acre where pea vines had been plowed in.

In 1889–90 the same seven plats were treated as in the preceding year, with the only difference that the pea vines when plowed in were well matured. The winter "was severe on all winter grain," and the wheat growing on the plats where no pea vines had been plowed under was somewhat injured. "The yields on the portion with peas were very good, although not as good as the year before." The fertilizers applied and the yields of wheat are tabulated as follows:

Yields of wheat per acre (1890).

No.	Application of fertilizer per acre.	Cost.	Yield per acre without pea vines.		Yield per acre with pea vines.	
			Bush.	*Lbs.*	*Bush.*	*Lbs.*
1	None		12	30	20	50
2	300 pounds kainit	$2.55	4	$22\frac{1}{2}$	21	40
3	300 pounds acid phosphate	2.70	4	10	25	50
4	175 pounds acid phosphate $87\frac{1}{2}$ pounds cotton-seed meal $37\frac{1}{2}$ pounds kainit	2.94	3	$32\frac{1}{2}$	24	10
5	None		1	40	15	50
6	300 pounds cotton-seed meal	3.60	5	..	12	$42\frac{1}{2}$
7	350 pounds acid phosphate 175 pounds cotton-seed meal 75 pounds kainit	5.88	11	$52\frac{1}{2}$	25	25
	Average yield per acre		4	44	20	53

"Especial attention is called to the yield on plat 3 with pea vines. It was the largest yield of any plat, and the cost of fertilizer moderate. This was the plat that produced the largest yield the year previous. So far this experiment proves that acid phosphate used with peas is the cheapest and best fertilizer for wheat."

North Carolina Station, Bulletin No. 77*b* (Technical Bulletin No. 2), July 1, 1891 (pp. 11).

INVESTIGATIONS OF THE ARSENITES WITH REFERENCE TO INJURIES TO FOLIAGE, B. W. KILGORE, B. S.—This is a report of investigations from a chemical standpoint to determine the cause of injury to foliage from the application of arsenites, and to find a means for its prevention. The experiments were made in July, 1890. The conclusions reached agree in general with those obtained from independent experiments at the Iowa Station, an account of which was published in Bulletin No. 10 of that station (see Experiment Station Record, vol. II, p. 215).

Chemical tests made in connection with spraying experiments with solutions containing white arsenic, London purple, or Paris green, and with Bordeaux mixture revealed the fact that "in no case was injury noticeable where soluble arsenic was absent, but in all cases it was proportional to the amount of soluble arsenic."

Seeing in this experiment the insolubility of the arsenites in Bordeaux mixture and the consequent exemption of foliage from injury, and knowing that London purple was, in the main, an arsenite of calcium, being produced by the decomposition of rosaniline arsenite by calcium hydrate (lime in solution), it was at once plain, from a chemical point of view, that lime would render the soluble portion of the arsenites insoluble in water, and thus render foliage free from injury from them. Various mixtures of an equal weight of pure lime (CaO) and white arsenic, London purple, and Paris green, separately in water, were made to test this point. Some of the mixtures contained as much as 4 pounds of arsenite in 100 gallons, but in only a few cases was so much as a trace of soluble arsenic found when tested by sulphureted hydrogen. [The results of the application of these mixtures to foliage are tabulated.] In every case where there was soluble arsenic there was also "burning" of foliage, and this in all cases was in direct proportion to the amount of soluble arsenic. Where there was no arsenic in solution there was no burning of leaves except in one case, where white arsenic and lime had been standing only 24 hours.

Another table shows the amount of soluble arsenic compounds found in 1 and 100 gallons of arsenical mixtures, 1, 3, 5, 7, and 24 hours, and 10 days after mixing, and the entire absence of such compounds when lime was present.

White arsenic, it will be seen, dissolves very slowly, requiring more than 10 days for complete solution, even in a large volume of water and at summer temperature, while the soluble portion of London purple goes into solution practically at once; and the same is approximately true of Paris green. * * * The beneficial effect of lime in the London purple mixture is due to its decomposing action upon the rosaniline arsenite by which insoluble arsenite of lime is formed. This change takes place in a short time, as will be seen from the loss of color of the mixture. Double and triple weights of lime to London purple were experimented with, thinking it might require these amounts to effect the decomposition, but an equal weight was found to be ample.

The beneficial effect of lime in Paris green and white arsenic mixtures is also due to the formation of the insoluble arsenite of lime. Equal weights of lime to Paris green and white arsenic each were found sufficient in all cases, and no more than this, even of the commercial article, need be added to Paris green. But to be on the safe side, I think it best to add 2 pounds commercial lime (CaO) to 1 pound white arsenic. One pound white arsenic (As_2O_3) requires approximately 0.85 pounds of lime (CaO) to satisfy the reaction in the production of the insoluble arsenite, but slight excess of lime does not seem to do any harm—certainly far less than an excess of arsenic.

A very cheap insecticide, having the same insecticidal properties as London purple, can be easily made by boiling together for one half hour, in 2 to 5 gallons of water, 1 pound commercial white arsenic and 2 pounds commercial lime, and diluting to required volume, say 100 gallons.

Other experiments showed—

(1) That Bordeaux mixture prevents the solubility of the arsenites and their injury to foliage by virtue of its lime.

(2) That the arsenites are more soluble in simple solutions of sulphate of copper, sulphate of iron, and chloride of iron than in water, and injure foliage more than when applied in water.

(3) That the arsenites are very soluble in eau celeste and eau celeste modified with soda mixtures, and do very great damage to foliage when applied in them.

(4) That kerosene emulsion is not a favorable medium for applying the arsenites.

North Carolina Station, Bulletin No. 78, July 10, 1891 (pp. 31).

SOME INJURIOUS INSECTS, G. MCCARTHY, B. S. (pp. 5–30, figs. 34).—This includes formulas for ten of the most common insecticides, illustrations of spraying apparatus, and illustrated notes on the following insects: Cotton caterpillar (*Aletia xylina*), bollworm (*Heliothis armigera*), red spider (*Tetranychus telarius*), tobacco worm (*Phlegethontius carolina*), flea beetle (*Crepidodera cucumeris*), greasy cutworm (*Agrotis telifera*), tree cricket (*Œcanthus niveus*), chinch bug (*Blissus leucopterus*), hill worm (*Elater* sp.), corn bill bug (*Sphenophorus zeæ*), corn plant louse (*Aphis maidis*), Hessian fly (*Cecidomyia destructor*), grain plant louse (*Siphonophora avenæ*), angoumois grain weevil (*Gelechia cerealella*), harlequin bug (*Murgantia histrionica*), cabbage caterpillar (*Pieris* sp.), striped cucumber beetle (*Diabrotica vittata*), Colorado potato bug (*Doryphora 10-lineata*), black blister beetle (*Cantharis nuttalli*), pea weevil (*Bruchus pisi*), codling moth (*Carpocapsa pomonella*), cankerworm (*Paleacrita vernata*), apple tree tent caterpillar (*Clisiocampa americana*), plum curculio (*Conotrachelus nenuphar*), peach borer (*Sannina exitiosa*), round-headed borer (*Saperda bivittata*), flat-headed borer (*Chrysobothris femorata*), pear twig girdler (*Oncideres cingulatus*), rose chafer (*Macrodactylus subspinosus*), grapevine leaf roller (*Desmia maculalis*), spotted grapevine caterpillar (*Procris americana*), grapevine flea beetle (*Haltica chalybea*), grape curculio (*Craponius inæqualis*), June bug (*Lachnosterna fusca*).

SOME BENEFICIAL INSECTS, G. MCCARTHY, B. S. (pp. 30, 31, figs. 4).—Brief illustrated notes on ladybugs (*Coccinella* sp.), lace-winged flies (*Chrysopa* sp.), banded soldier bug (*Milyas circinatus*), and tiger beetle (*Passimachus elongatus*).

Ohio Station, Bulletin Vol. III, No. 11 (Second Series), December, 1890 (pp. 72).

NINTH ANNUAL REPORT, 1890.—This includes the reports of the board of control, treasurer (for fiscal year ending June 30, 1890), director, agriculturist, entomologist and botanist, veterinarian, and meteorologist, and the "Insect Record for 1890." The reports consist for the most part of brief outlines and condensed summaries of the work of the year. A table of contents for the bulletins of 1890 is given in an appendix, and brief synopses of these are contained in the director's report. There is also an index to the publications of the year.

Report of Meteorologist, W. H. Baker.—This includes tabulated daily and monthly summaries of observations for the station and the State of Ohio, and a yearly summary for each year from 1883 to 1890, inclusive.

Annual summaries of meteorological observations for the State of Ohio, 1883–90.

TEMPERATURE.

[Degrees F.]

Year.	Mean.	Highest.	Lowest.	Maximum range.	Mean daily range.	Maximum daily range.	Minimum daily range.
1883	49.4	98, Aug. 22	—17.2, Jan. 22	115.5	19.8	55.2, Mar. 18	0.5, Dec. 23.
1884	50.6	99, Sept. 28 and Oct. 1.	—34, Jan. 25	133	20.5	50, Sept. 5 and Dec. 4.	1.1, Feb. 6.
1885	48.0	101, July 21	—31, Jan. 29	132	20.4	58.5, Jan. 30	1.0 Apr. 18 and Dec. 31.
1886	49.6	98.6, July 7	—21.5, Jan. 12	120.1	20.2	57, Dec. 11	1.1, Mar. 27.
1887	51.4	108, July 18	—21, Jan. 7	129	21.2	57, Apr. 11	1.0, Jan. 15 and Apr. 16.
1888	49.5	102	—15, Jan. 27	117	19.6	50	1.2, Jan. 16.
1889	51.1	99.5, Aug. 31	—13.5, Feb. 24	113	19.3	53, Mar. 30	1.0, Jan. 5.
1890	52.4	103.1, Aug. 3	—4, Mar. 7	107.1	19	49.5, Apr. 11	1.0, Dec. 17.
Summary for 8 years.	50.3	108, July 18, 1887	—34, Jan. 25, 1884	142	20	58.5, Jan. 30, 1885	0.5 Dec. 23, 1883.

HUMIDITY, WIND, AND WEATHER.

Year.	Mean relative humidity.	Yearly rainfall.	Prevailing direction of wind.	Number clear days.	Number fair days.	Number cloudy days.	Number rainy days.
	Per cent.	*Inches.*					
1883	76.3	44.98	SW	98.2	135.4	130.4	146.0
1884	76.8	40.19	SW	116.7	118.3	131.1	145.0
1885	77.5	38.08	SW	103.5	132.8	128.2	147.7
1886	77.8	36.71	SW	118.4	125.7	121.0	130.7
1887	75.8	33.63	SW	113.8	127.3	123.9	120.9
1888	78.2	39.64	SW	108.7	123.4	133.9	124.7
1889	79.4	33.53	SW	112.8	113.8	138.4	114.8
1890	80.2	50.33	SW	103.4	121.6	140.3	149.4
Summary for 8 years	77.7	40.89	SW	109.4	124.7	130.8	134.9

Insect Record for 1890, C. M. Weed, D. Sc.—Brief illustrated notes are given on the following insects, which were more or less prevalent in Ohio during 1890: Woolly maple bark louse (*Pulvinaria innumerabilis*), walnut caterpillar (*Datana angusii*), yellow-necked apple tree caterpillar (*Datana ministra*), white-marked tussock moth (*Orgyia leucostigma*), grain plant louse (*Siphonophora avenæ*), oyster-shell bark louse (*Mytilaspis pomorum*), scurfy bark louse (*Chionaspis furfurus*), buffalo tree hopper (*Ceresa bubalus*), plum curculio (*Conotrachelus nenuphar*), codling moth (*Carpocapsa pomonella*), chinch bug (*Blissus leucopterus*), Hessian fly (*Cecidomyia destructor*), striped cucumber beetle (*Diabrotica vittata*), imported cabbage worm (*Pieris rapæ*), cabbage aphis (*Aphis brassicæ*), willow grove plant louse (*Melanoxanthus salicti*), white pine plant louse (*Lachnus strobi*), potato stalk borer (*Trichobaris trinotata*), and apple maggot (*Trypeta pomonella*).

The following interesting discovery is reported in the case of the cabbage aphis:

During November we discovered that the sexual generation develops late in autumn on the cabbage, and that the eggs are laid on the cabbage leaves. The true male is a small, winged creature, with a more slender body than the other winged forms. The egg-laying female has no wings and is pale green in color.

This discovery of the fact that the insect passes the winter in the egg state on the cabbage leaves has an important economic bearing. It suggests as one of the best ways of preventing the injuries of this pest, the destruction during winter of the old cabbage leaves with the eggs upon them, instead of leaving them undisturbed until spring, as is too often done.

Several kinds of spraying apparatus tested at the station are described and illustrated. The article is illustrated with two plates and nine figures, a number of which are original.

Pennsylvania Station, Bulletin No. 16, July, 1891 (pp. 18).

CHESTNUT CULTURE FOR FRUIT, W. A. BUCKHOUT, M. S. (pp. 3-11).—A discussion of the advantages of cultivating nuts, especially chestnuts, in Pennsylvania.

[The chestnut] is adapted to the climate of Pennsylvania and grows well on the light, gravelly soils of hillsides, though not thriving on heavy limestone land. It may be propagated as a seedling from second growth sprouts, and by grafting of named varieties upon native stocks; varieties, too, may be improved by hybridization. In addition to its fruit its wood is of great value and its bark is used for tanning.

For planting the seed must be kept moist, and must be covered by sand or sawdust until planted, which is best done in the fall, at not too great a depth, and with careful firming. Plant where the trees are to remain, for transplanting is exceptionally injurious to the young chestnut. European and Japanese varieties, though not hardy in our climate, do well on native stalks, produce more and better fruit than our small native variety, and sometimes bear in 4 years. Top-graft on vigorous stalks just starting into growth; cut the scions early, and keep dormant till grafted, as in case of apples. Scions may be obtained from most nurserymen. To secure early and best bearing, trees must not be too closely planted, and bushes and other trees must be cut away sufficiently to prevent interference, so that there shall be a low, round-headed development.

ANALYSIS OF SEVERAL VARIETIES OF CHESTNUTS, W. FREAR, PH. D. (pp. 12-18).—General statements regarding the composition of chestnuts, and tabulated results of analyses with explanatory notes. The following tables are from the bulletin:

Proportion of shell and kernel.

Name.	1	2	3	4	5	6	7	8
	Spanish.	Paragon.	Spanish.	Numbo.	Moon's Seedling.	Solebury.	Native.	Native.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Shell	21.51	23.94	25.25	11.49	14.32	15.32	23.24	22.87
Kernel:								
Water	6.63	6.53	5.43	42.25	47.66	29.17	34.45	4.82
Dry matter	71.86	69.53	69.33	46.26	44.02	55.51	42.31	72.31
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Composition of chestnut varieties—water-free.

	1	2	3	4	5	6	7	8
	Spanish.	Paragon.	Spanish.	Numbo.	Moon's Seedling.	Solebury.	Native.	Native.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Crude ash	3.03	3.12	2.87	3.18	3.05	2.51	2.66	2.72
Crude fiber	2.55	2.68	2.84	3.74	3.26	2.53	3.63	2.84
Crude fat	7.11	9.76	9.58	11.46	11.00	11.67	16.42	16.08
Crude protein:								
Albuminoids	8.38	10.91	9.28	8.68	9.63	8.07	11.84	10.53
Amides, etc	1.23	1.23	1.68	1.90	1.11	1.44	0.39	1.67
Total	9.61	12.14	10.96	10.58	10.74	9.51	12.23	12.20
Nitrogen-free extract:								
Glucose	5.19	9.13	12.63	6.76	6.71	13.78	14.06	8.50
Dextrine	17.45	11.05	8.23	14.40	14.74	15.02	7.63	12.01
Starch	24.24	32.15	23.87	20.49	33.95	34.27	16.81	50.65
Other material	30.84	19.97	29.02	29.39	16.55	9.73	26.63	
Total	77.70	72.30	73.75	71.04	71.95	72.80	65.03	66.16

*Other analyses of nuts and grains.**

	Dry matter.	Water-free. Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Other analyses of chestnuts:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Payen	45.79	4.04	7.23	....	....	....
Dietrich	51.25	3.21	6.36		87.02	3.41
Nessler and von Fellenburg:						
Marones	(?)	3.16	14.50	3.00	76.73	2.61
Early chestnuts	(?)	3.51	15.75	3.63	74.50	2.61
Late chestnuts	(?)	3.69	12.70	3.34	77.76	2.51
Albini, from a number of Italian varieties, obtained the following:						
Minima	(?)	3.00	5.20	6.50	63.50	1.20
Maxima	(?)	3.30	9.30	8.40	78.20	2.10
König's mean	48.52	3.54	11.29	3.32	79.03	2.82
Other nuts:						
Sweet almonds	94.61	3.13	25,56	6.93	7.64	56.74
Walnuts	95.32	2.13	17.17	6.47	8.28	65.95
Hazelnuts (filberts)	96.23	1.90	16.24	3.40	9.38	69.08
Acorns (shelled)	59.88	2.32	7.21	5.71	80.17	4.59
Peanuts	93.50	3.48	30.21	....	....	49.61
Cocoanuts (meat)	53.36	1.81	10.29	5.45	15.10	67.35
Grains:						
Wheat	86.35	2.09	14.30	2.93	78.65	2.03
Corn	86.88	1.74	11.33	2.87	78.74	5.32
Beans	85.24	3.82	28.47	8.32	57.50	1.89

* From König's work on Human Foods.

† Sum of sugar, dextrin and starch.

The principal facts relating to the composition of the chestnut may be summarized as follows:

(1) Chestnuts, like acorns, are starchy rather than oily nuts; they keep better, and are more digestible than the latter, though the air-dry nuts contain much more water; their dry matter is not, however, so rich in protein. The European chestnut closely approaches wheat in composition, but contains less starch and more dextrose and other water-soluble carbohydrates.

(2) The small, uncultivated American chestnuts are more oily than the nuts grown in Europe, and contain less starch, though they differ little from the other varieties in their content in sugars, protein, fiber, etc.

(3) Varieties of European stock, when grown in this climate, though carefully cultivated, and attaining normal size, apparently tend to become more oily, poorer

in carbohydrates, and possibly less albuminous. On the other hand, Moon's Seedling, produced from American stock, had only three fourths as much fat as the native nuts, and less protein, and in general closely resembled the seedlings of European origin grown in the same locality.

Utah Station, Bulletin No. 7, July, 1891 (pp. 19).

DRAFT OF MOWING MACHINES, J. W. SANBORN, B. S.—Accounts are given of dynamometer tests of the draft of mowing machines of several different kinds, in cutting grass, clover, and alfalfa, and under varying adjustments. The following summary is taken from the bulletin:

(1) A difference of draft was found in mowing machines, but not great, save in favor of one machine. This difference seemed to follow speed.

(2) The draft of mowing machines varied in their relations to each other in varying kinds of mowing. This seems to be due to speed; therefore they should have two or more pinions.

(3) The draft of machines varied with the point of attachment for draft.

(4) The draft was 8.7 per cent greater for a well-sharpened sickle than for one more nicely sharpened.

(5) An old machine well repaired drew easier than a new one.

(6) A 6-foot cutter bar drew easier per foot of cut than a 4½-foot cutter bar, and at a draft less than a plow carrying an average furrow; therefore a pair of horses can draw a 6-foot cutter bar.

(7) A pitman box set tight gave a draft less than one run quite loosely.

(8) A heavy loss (7.6 per cent) of force was observed when the truck at the end of the cutter bar failed to roll.

(9) When cutter bar is not near right line with pitman rod the draft is increased.

(10) When guards are not true draft is increased.

(11) When cutter bar is inclined upward the draft is decreased.

(12) The draft was decreased 10 pounds by the driver walking.

(13) When the sections of the sickle do not strike in the center of the guard the draft is increased.

Virginia Station, Bulletin No. 10, June, 1891 (pp. 27).

STEER FEEDING, D. O. NOURSE, B. S. (pp. 4–13).—It was the purpose of this experiment to compare the effects (1) of corn silage and hay, and (2) of whole corn and corn meal, both with regard to gain in live weight and to cost of food per pound of gain. Twelve steers, about 2½ years old, were divided into six lots of two animals each, and after a preliminary period of a week were fed continuously from February 10 to April 14 as follows:

Lot 1, 37 pounds silage with 12 pounds corn meal.
Lot 2, 37 pounds silage with 12 pounds whole corn.
Lot 3, 37 pounds silage with 8 pounds corn meal and 8 pounds bran.
Lot 4, hay *ad libitum* with 12 pounds corn meal.
Lot 5, hay *ad libitum* with 12 pounds whole corn.
Lot 6, hay *ad libitum* with 8 pounds corn meal and 8 pounds bran.

The animals of lots 1, 2, and 3 were also given hay *ad libitum* in addition to the silage, but in the rations of the remaining three lots the coarse fodder consisted entirely of hay.

The results are fully tabulated in the bulletin, and from these the following statement, showing the average per animal for each lot, is taken. In the calculations of the cost of food, corn meal, whole corn, and bran were each reckoned at $20 per ton, hay at $10, and silage at $2.50, and no allowance was made for the value of the manure.

Averages per animal during entire experiment.

Kinds of food.	Dry matter in food consumed.	Gain in live weight.	Total cost of food.	Cost of food per pound of gain.
	Pounds.	*Pounds.*		*Cents.*
Lot 1, silage and corn meal	1,502.1	180	$13.05	7.35
Lot 2, silage and whole corn	1,415.0	127	11.99	9.30
Lot 3, silage, corn meal, and bran	1,697.9	179	14.89	8.30
Average of three lots on silage	1,538.3	162	13.31	8.20
Lot 4, hay and corn meal	1,392.0	128	11.89	9.35
Lot 5, hay and whole corn	1,315.7	69	11.30	17.50
Lot 6, hay, corn meal, and bran	1,533.8	135	13.95	10.35
Average of three lots on hay	1,413.8	110.7	12.38	11.20

Comparing, first, the silage and hay it would seem from the above that in this trial those animals receiving silage consumed the largest amount of dry matter and made a larger gain in live weight than those receiving hay instead of silage; the silage, however, contained a large amount of water, which introduces a factor difficult to make allowance for. The extra amount of water taken into the body may have increased the apparent gain, although there was a continuous increase in weight to the end of the experiment, as will be seen from the following averages:

Gain per animal.

	With silage.	With hay.
	Pounds.	*Pounds.*
First 3 weeks	66.3	43.3
Second 3 weeks	57.7	46.3
Third 3 weeks	38.0	21.0

The sudden falling off in the average amount of gain after the first 6 weeks of feeding is noticeable both where silage and where hay were fed. The average cost of food per pound of increase was 8.2 cents with silage and 11.2 cents with hay.

"It would seem that a variation so great as this would not all be accounted for by individual peculiarities, but rather by the fact that silage is very economical to give in moderate quantities to fattening animals."

As between corn meal and whole corn the data indicate the former to be the most economical, for while the average cost of food per pound of increase in the lots receiving corn meal was 7.35 and 9.35 cents respectively, it was 9.3 and 17.5 cents with those receiving whole corn instead.

"Perhaps the price of whole corn is too high, as it costs considerable to convert it into meal, but allowing one seventh for toll the balance is still much in favor of the meal-fed lot."

PIG FEEDING, D. O. NOURSE, B. S. (pp. 14–27, plates 6).—This experiment was intended to get additional information as to the effect of highly carbonaceous and of highly nitrogenous rations on the development of fat and lean meat in pigs.

Nine pigs were selected for the trial, six of which were Berkshire barrows, about 5 months old at the beginning of the trial, and the remaining three a cross of Poland-China and Jersey Red, which had been at pasture and "were the largest lean hogs, even in size and quality, we could procure"; they were from 7 to 9 months older than the Berkshires. The pigs were divided into three lots of as nearly equal weight as possible, each lot containing two Berkshires and one of the older hogs. Each lot received a different ration, as follows:

Lot 1, corn meal alone; nutritive ratio 1:9.05.
Lot 2, 10 parts corn meal, 4 of bran, and 1 of beef scrap; nutritive ratio 1:5.82.
Lot 3, 5 parts corn meal, 2 of bran, and 2 of beef scrap; nutritive ratio 1:2.35.

Each pig was fed twice daily in a pen by itself, only as much food being given as would be consumed without waste. Ashes, charcoal, and salt were given, but not mixed with the food. The animals were weighed at the end of each week, before feeding.

The experiment was commenced August 19; October 16 two of the pigs in lot 3 died, and October 31 the third one died. An examination showed that "death was probably caused by lack of power to assimilate the food." The feeding of lots 1 and 2 was continued until November 25, when they were slaughtered.

Seven tables give the weights of the animals, food consumed, dry substance consumed per 100 pounds live weight and per pound of increase, cost of food per pound of gain, data obtained at time of slaughtering, etc.; and six plates show cross sections of the carcass of each pig. There was no perceptible difference in the proportion of fat and lean meat in the hogs of the different lots. The cost of the rations is based on corn meal at $20, bran at $20, cotton-seed meal at $25, and beef scrap at $40 per ton, making no allowance for the value of the manure. The gains and cost per pound of gain for lots 1 and 2 were as follows:

Gain per animal, and cost of food per pound of gain.

	Lot 1.				Lot 2.			
	No. 1.*	No. 2.	No. 3.	Average.	No. 4.*	No. 5.	No. 6.	Average.
Weight at beginning of experiment, pounds	130.25	114.50	103.00	115.92	127.00	108.25	109.50	114.92
Gain in live weight during experiment, pounds	140.25	90.75	137.75	122.92	189.50	157.50	153.75	166.92
Cost of food per pound of gain, cents	4.9	6.6	4.4	5.3	4.1	4.8	5.4	4.8

*Had been at pasture previous to the experiment.

The author makes the following inferences from the results:

(1) A very narrow ration is not fed with economy, and may, as in this case, even cause death through lack of power of the animal to assimilate food in so concentrated a form.

(2) Not the slightest difference is made in the proportions of fat and lean meat in pigs fed corn meal alone and corn meal, beef scrap, and bran.

(3) The second lot lost more in 24 hours after being dressed, and slightly more moisture was found in both fat and lean meat when dried at 100°C.

(4) The cost per pound increase in live weight was 0.5 of a cent in favor of the bran-fed lot [lot 2].

(5) The cost per pound of gain in live weight of lot 1 was 5.3 cents, and of lot 2, 4.8 cents. As a whole, the second food was the more economical, owing perhaps to the greater relish with which it was eaten.

Wyoming Station, Bulletin No. 2, August, 1891 (pp. 8).

PLANT LICE, F. J. NISWANDER, B. S. (pp. 27-31, figs. 3).—Brief general notes on plant lice affecting cottonwood trees and the means for their repression.

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF STATISTICS.

REPORT NO. 87 (NEW SERIES), AUGUST, 1891 (pp. 377–437).—This includes articles on the condition of the growing crops of corn, spring wheat, spring rye, barley, buckwheat, oats, potatoes, tobacco, cotton, grasses, canes, and fruits; European crop report for August; Indian wheat crop of 1891; the Raiffeisen loan associations of Germany; and the freight rates of transportation companies.

Indian wheat.—The final official returns of the Government of India of the wheat crop of 1890–91 make the area under wheat 26,424,000 acres, as compared with 24,773,000 last year, and a normal or average for 5 years of 26,479,000. The product is given as 6,842,000 tons, or 255,434,667 bushels, while that of last year was 6,123,000 tons, or 228,502,000 bushels. Last year was unfavorable for wheat production in India. The increase of acreage of this year over last amounted to 651,000 acres, and of production, 26,842,667 bushels.

DIVISION OF ENTOMOLOGY.

INSECT LIFE, VOL. III, NOS. 11 AND 12, AUGUST, 1891 (pp. 433–519, figs. 5).—The principal articles in this double number are: Some Icerya and Vedalia Notes; Experiments with a Date Palm Scale (*Parlatoria zizyphi*, Lucas); A Viviparous Cockroach (*Panchlora viridis*), by C. V. Riley; The Grasserie of the Silkworm, by P. Walker; Observations on Injurious and other Insects of Arkansas and Texas, by F. M. Webster; An Encyrtid (*Hexacladia smithii*, n. sp.) with Six-Branched Antennæ, by W. H. Ashmead; History of the Hydrocyanic Acid Gas Treatment for Scale Insects, by D. W. Coquillett; Some of the Bred Parasitic Hymenoptera in the National Collection (continued); and Description of a New Tortricid (*Semasia bucephaloides*, n. sp.), by Lord Walsingham. The text of the Massachusetts law against the Gypsy moth (*Ocneria dispar*), and the regulations of the state board of agriculture for carrying out the provisions of the law, are given in full. Indexes to vol. III accompany this number.

DIVISION OF ORNITHOLOGY AND MAMMALOGY.

NORTH AMERICAN FAUNA NO. 5.

RESULTS OF A BIOLOGICAL RECONNOISSANCE OF SOUTH-CENTRAL IDAHO, C. H. MERRIAM (pp. 1–113, plates 4, figs. 4).—The reconnoissance was made by the author and his assistants during August, September, and October, 1890, in Idaho, south of latitude 45° and east of the 38th meridian. The report includes an itinerary, descriptions of the several regions traversed, a provisional definition of the life zones of Idaho, check and annotated lists of the mammals of Idaho with descriptions of new species, an annotated list of birds observed in Idaho during the reconnoissance with notes on species previously recorded from the State, and an annotated list of reptiles and batrachians collected by the expedition, prepared by L. Stejneger.

Idaho presents great diversity of physical features, comprising immense coniferous forests, ranges of lofty rugged mountains, fertile grassy valleys, arid sagebrush plains and alkali deserts, and it is about equally divided between the Boreal [altitudes above 7,500 feet] and Sonoran [altitude below 6,400 feet] life zones. Its mammal fauna is correspondingly rich and varied. Sixty-seven species and subspecies of mammals are now known from the State and the number will be increased by future explorations. The principal additions are likely to come from the bats and arvicoline mice, and, except in so far as the former group is concerned, the numerical relations of the several families are not likely to be disturbed; hence a statement of the number of genera and species in each may be of interest. For convenience subspecies are here treated as species. The Boreal group *Mustelidæ* leads in genera but not in species, having 8 genera and 9 species. The family *Muridæ* comes next in number of genera and outranks the *Mustelidæ* in species, having 7 genera and 13 species, and the number of species is likely to be slightly increased. The *Sciuridæ* is represented by 5 genera and 10 species; the *Cervidæ* by 4 genera and 5 species; the *Bovidæ* by 4 genera and 4 species; the *Canidæ* by 2 genera and 3 species; the *Felidæ* by 2 genera and 2 species; the *Soricidæ* and *Leporidæ* each by 1 genus and 4 species; the *Saccomyidæ* by 2 genera and 2 species; the *Geomyidæ* by 1 genus and 2 species; the *Ursidæ* by 1 genus and 2 species; and the following families by 1 genus and 1 species each: *Hystricidæ, Zapodidæ, Lagomyidæ, Castoridæ, Procyonidæ*. The *Vespertilionidæ* is probably represented by 3 genera and 4 or 5 species. The genera most largely represented in species are, *Arvicola* 5, *Spermophilus* 4, *Lepus* 4, *Sorex* 4, *Tamias* 3. No other genus has more than 2 species.

The new species and subspecies of mammals described are *Sorex idahoensis, S. dobsoni, S. vagrans similis, Onychomys leucogaster brevicaudus, Hesperomys crinitus, Arvicola macropus, A. mordax, A. nanus, Phenacomys orophilus, Evotomys idahoensis, Thomomys clusius fuscus, Lepus idahoensis.* The list of birds includes 157 species. A new subspecies of owl, named the dwarf screech owl (*Megascops flammeolus idahoensis*), is described and illustrated in a colored plate.

DESCRIPTIONS OF A NEW GENUS AND TWO NEW SPECIES OF NORTH AMERICAN MAMMALS, C. H. MERRIAM (pp. 115–119).—A new genus and species of dwarf kangaroo rat (*Microdipodops megacephalus*) from Nevada is described from six specimens collected in Nevada in October and November, 1890; and a new subspecies of red-backed mouse (*Evotomys gapperi brevicaudus*) is described from two specimens collected in the Black Hills of South Dakota in July, 1888.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

The grading of bone meal. J. König (*Landw. Ztg. f. Westfalen u. Lippe, 1891, pp. 265, 266*).—Professor König designates as "normal" that bone meal which has been freed of its fat by chemical means (dissolving in benzine, carbon bisulphide, etc.), leaving the gelatin unattacked. It thus contains from 4.5 to 5.2 per cent of nitrogen, and from 19.5 to 23 per cent of phosphoric acid. He states that it is a common practice among manufacturers in Germany to mix with the pure meal prepared in this way meal from which the gelatinous materials have been extracted by treating with superheated steam, thus furnishing a mixture which has a somewhat smaller percentage of nitrogen and a larger percentage of phosphoric acid than the so-called normal meal. The percentage of nitrogen is further dependent on the amount of meat, horn, etc., which is mixed with the bones and which he pronounces of less manurial value than the gelatinous materials of the bones. These other nitrogenous materials can be quantitatively separated from the bones, he says, by shaking with chloroform; being lighter than the bone they rise to the surface. Normal bone meal may contain from 1 to 5 per cent of such materials, but not more than this amount should be present. He suggests that the quality of the bone meal may be safely graded on the basis of the relation of the phosphoric acid to the nitrogen remaining after extraction with chloroform, and he proposes the following classification:

(1) Bone meal containing 4–5.3 per cent nitrogen and 19.5–23 per cent phosphoric acid, and in which after treatment with chloroform the nitrogen and phosphoric acid are in the proportion of 1:4–5.5, is to be designated as *normal bone meal*, or *bone meal No. 0.*

(2) Bone meal containing 3–4 per cent nitrogen and 21–25 per cent phosphoric acid, and in which after treatment with chloroform the proportion of nitrogen to phosphoric acid is as 1: 5.5–8.5, he designates simply as *bone meal.*

(3) Bone meal containing 1–3 per cent of nitrogen and 24–30 per cent of phosphoric acid, the proportion after treatment with chloroform being as 1:8.5–30, he designates as *degelatinized bone meal.*

(4) Only such meal is designated as *raw* as has been prepared by pulverizing raw untreated bones.

(5) Meal which after treatment with chloroform contains less than 1 per cent of nitrogen derived from the bone gelatin, and in which the relation of nitrogen to phosphoric acid is wider than 1:30, is not to be classed as a bone meal, but designated as *mixed fertilizer meal.*

Experiments on continuous growing of grain at Woburn, England, J. A. Voelcker (*Jour. Roy. Agl. Soc. of England, 3 ser., 2, pp. 362–366*).—These experiments were commenced in 1877, and were designed to show the effects of various artificial manures and barnyard manure upon grain crops grown year after year on the same land. The results are here reported for the years 1889 and 1890, the thirteenth and fourteenth years of the experiments. The plats were one fourth acre each, and the same fertilizers have, except in a few cases, been used each year since 1877 on the respective plats.

Continuous growth of wheat.—The variety of wheat grown was Browick Red, of which 9 pecks per acre were dibbled in by hand in the fall of each year. The fertilizers applied per acre consisted of ammonium salts (sulphate and chloride in equal parts) and nitrate of soda, each in amounts equivalent to 50 pounds of ammonia per acre, used singly; a mixture of 200 pounds of potassium sulphate, 100 pounds of sodium sulphate, 100 pounds of magnesium sulphate and 350 pounds of superphosphate of lime, which was used alone and to which was added, in separate cases, ammonium salts equivalent respectively to 50 and 100 pounds of ammonia, and nitrate of soda equivalent to 50 and 100 pounds of ammonia; rape cake, 800 and 1,600 pounds respectively, furnishing nitrogen equivalent to 100 and 200 pounds of ammonia; and barnyard manure estimated to contain nitrogen equivalent to 200 pounds of ammonia. Two plats have received no fertilizer whatever since 1877, and one plat has received only the mineral fertilizers (potassium, sodium, and magnesium sulphates, and superphosphate of lime). The mineral manures were applied just before seeding, the top-dressings of ammonia salts and nitrate of soda in the spring (April), the barnyard manure early in February, and the rape cake in the latter part of January.

The yields of the duplicate unmanured plats agree very closely in 1889; in 1890 plat 7 is rather higher. Minerals alone, without nitrogen, have as usual given no increase. In 1889 ammonia salts, whether used alone or with mineral manures, produced a larger crop than nitrate of soda, but in the drier year, 1890, the exact reverse was the case, nitrate of soda in each instance then showing the higher return. The appearance of the plats on which these nitrogenous top-dressings are used is in the earlier stages very poor, and the plant is very uneven; nevertheless, toward harvest they seem to pull up wonderfully, and the yield is much more than it has seemed likely to be. The small increase (2 bushels) from putting on in 1889 the double dressing of nitrate of soda is very noticeable, and while the omission of ammonia salts for a single year reduces the grain to 21 bushels, the effect of leaving out nitrate of soda is to take it as low as 11.4 bushels, which is even below the unmanured yield. This greater diminution in the case of nitrate of soda is also very marked in 1890. The effect of rape cake, applied so as to give 100 pounds of ammonia per acre, is greater than that of farmyard manure estimated to contain double that amount. Plat 11*a* [unmanured, having been manured last in 1882 with barnyard manure] still seems to show the presence of some unexhausted fertility from the farmyard manure put on in former years.

Continuous growth of barley.—The fertilizers used in this experiment were the same in kind and amount as those in the experiment with

wheat described above. Golden Melon barley was sown at the rate of 9 pecks per acre. The mineral manures were applied just before seeding, the barnyard manure as a top-dressing just after sowing, the rape cake at about the same time, and the top-dressings of ammonium salts and nitrate of soda in the spring. The indications from the tabulated results are in the words of the author as follows:

Mineral manures produced no increase in 1889, and only about 3 bushels in 1890. The results from the use of nitrate of soda or from ammonia salts when used alone were closely alike both years, but used in combination with minerals, nitrate of soda gave about 2 bushels increase and considerably more straw. Doubling the dressing of nitrate of soda gave only 1 bushels in 1889, and 2 bushels extra in 1890. Rather more relative increase was obtained from doubling the ammonia salts, but nitrate of soda gave the higher total yields. The omission of the top-dressing [of ammonia salts or nitrate of soda] for a single year did not in either season give such marked distinctions as heretofore, between ammonia salts and nitrate of soda when severally omitted. Thus, in 1889, when ammonia salts were left out, the yield fell to 21.9 bushels, and to 18 bushels when nitrate of soda was not put on; but in 1890 the crop grown on the residue of the nitrate of the former year was even higher than that from the ammonia salts. It is only fair, however, to mention that in this year plat *8a* was very patchy indeed. In 1889 neither farmyard manure nor rape cake applied as top-dressing told well, and in 1890 the effect of the rape cake was not nearly so marked, when compared with the farmyard manure, as in the case of the wheat crop.

Experiments with potatoes, J. A. Voelcker (*Jour. Roy. Agl. Soc. of England, 3 ser., 2, pp. 376, 377*).—In this experiment the fertilizers used were (1) manure produced by steers fed on roots, hay, linseed cake 2.8 pounds, barley 4 pounds, and decorticated cotton cake 3.3 pounds per head daily; (2) manure produced by steers receiving the same ration, except that undecorticated cotton cake was substituted for decorticated; (3) a barnyard manure "of indefinite nature;" and (4) a mixture composed of 300 pounds of superphosphate, 300 pounds of kainit, and 200 pounds of sulphate of ammonia per acre. The results follow:

Yield of potatoes per acre.

Plat.	Manure per acre.	Yield per acre.
		Pounds.
1	12 tons dung (decorticated cotton cake)	17 [illegible]45
2	12 tons dung (undecorticated cotton cake)	14 687
3	12 tons farmyard manure	15 658
4	800 pounds mixed fertilizer	18 987

"By this it will be seen that the artificial manure produced the largest crop, and it is worthy of note that there were no more small potatoes in this produce than in any of the others. The most interesting part of the experiment, however, is that which brings out the superior manurial effect of the decorticated cotton-cake dung as against that from the undecorticated cake."

Relation between the quality of tobacco and its composition, M. Barth (*Landw. Vers. Stat., 39, pp. 81–101*).—The author reviews the investigations of Nessler which recognized the injurious effects of

chlorine compounds and the beneficial effects of potash compounds, especially those with organic acids on the burning qualities of the leaf, and refers to the recognized injurious effects resulting from the use of night soil on tobacco, since it contains considerable quantities of chlorine compounds, induces a coarse growth, etc. Soil to which night soil has been applied for many years may contain so large amounts of chlorine compounds as to be unsuitable for the raising of tobacco, even when the proper fertilizers are applied. Nessler recommended in such cases the preparation of the land for tobacco by previous cropping with such plants as were known to use chlorine compounds in large quantities, as root crops; but in the opinion of the author this practice should be avoided as far as possible, since the root crops not only remove the chlorine, but they also, like tobacco, require large quantities of potash. The potash thus taken away from the soil can not, he believes, be replaced by artificial manures, since the root crops take their potash largely from the supply of potash contained in the soil material itself, which is said to be a form essential to the growth of tobacco also. For, he says, tobacco requires for its most successful cultivation not merely a heavy manuring with potash manures, but also a soil rich in natural potash resources, which by gradual disintegration shall furnish a large proportion of the potash needed by the crop.

Soils which on account of their deficiency in readily soluble potash produce a tobacco with only a small content of potash and of poor burning quality, are designated as "tobacco sick," and will produce a poor quality of tobacco unless by heavy manuring with potash and avoiding the cropping with plants which are heavy potash feeders, for a number of years in succession, opportunity and time are given to recover the supply of soluble potash. For this reason the author recommends that to secure the best results to plant and land, tobacco be planted on the same land only once in 3 or 4 years, or in regions where the land is found to be naturally tobacco sick only once in 5 or 6 years; to plant in the mean time no hoed crops or other fodder plants, but instead cereals, which produce less leaf growth; to give the usual liberal application of barnyard manure either to the intervening crops or to the tobacco itself, and in the latter case the manure should be applied in the fall, as recommended by A. Mayer; and to strenuously avoid the use of all fertilizing materials containing chlorine. He recommends in addition to the barnyard manure a dressing consisting of about 130 pounds of potassium sulphate or 250 pounds of potash-magnesium sulphate, with 90 pounds of Thomas phosphate meal per acre applied in the fall, and 400 pounds of nitrate of soda applied in the spring, half just before the plants are set and the remainder when the plants are about half developed.

With reference to the relations existing between the chemical composition and the quality of tobacco, a large number of examinations have been made under the direction of the author at the experiment station at Rufach, in Alsace, of different varieties of tobacco grown in

1888, 1889, and 1890 in three different localities in Alsace. As a result of these studies the author is led to conclude that the burning quality of the leaf (duration of glowing) is benefited in the highest degree by the presence of large amounts of potash, particularly that combined with organic acids (which in the ash changes to carbonate); by a delicate structure of the leaf (dried leaves, weighing 150 grams or less per square meter, he designates as delicate); and, although in a somewhat less degree, by the presence of considerable quantities of organic nitrogenous substances, especially nicotine, which at the same time has an effect on the quality of the product in general, and by a noticeable content of saltpeter. Detrimental to the burning quality were found to be first of all the chlorine compounds, as already mentioned; a coarse structure of the leaf (leaves weighing 200 grams or more per square meter of dry leaf are designated coarse); and, in a less degree, the presence of any considerable amounts of ammonium salts, phosphoric acid, resinous substances, or calcium salts.

The presence in the same leaf of conditions both favorable and unfavorable to burning quality, which in a test tend to cover up the effects of any single compound or condition, makes it very difficult to determine the effects of any single factor. For this reason Nessler* and later A. Mayer † have studied this matter by impregnating paper with various materials and observing the effect on the duration of glowing. The author pursued this course, using filter paper, which of itself glowed 3 seconds, and straw paper, which glowed 15 seconds, and impregnating in separate instances with 2 per cent solutions of potassium or sodium phosphate, a 3 per cent alcoholic solution of resin, and a solution of 10 grams of fresh liquid egg albumen in 100 c. c. of water. The results with both papers plainly show that in these trials the phosphates, in particular potassium phosphate, and the resins are very detrimental to the protracted glowing, and tend rather to induce charring; the albuminoids, on the contrary, favored a protracted glowing.

The results of A. Mayer's ‡ investigations led him to suggest the impregnation of tobacco of poor burning quality with a half per cent solution of either acetate or nitrate of potash by submerging for 24 hours. He states that he has been able by this treatment to change a poorly burning tobacco, which for this reason could only be used for snuff, to a tobacco of a good burning quality, giving a snow-white ash.

Composition of tomatoes. N. Passerini (*Staz. Sper. Agrar., 18, pp. 545–572; abs. Jour. Chem. Soc., 60, p. 956*).—According to the investigations of Passerini the fresh fruit of tomatoes consists of 1.3 per cent skin, 96.2 per cent pulp and juice, and 2.5 per cent seeds. The pulp contains two coloring matters, a yellow amorphous substance, and a

* Der Tabak, Mannheim, 1867. † Landw. Vers. Stat., 38, p. 130.

‡ Landw. Vers. Stat., 38, p. 138.

red crystalline substance. They are both insoluble in water, soluble in amyl alcohol, and very soluble in ether; and both are decolorized by chlorine water or bromine water. Cold alcohol dissolves the red crystals but slightly, while the yellow compound is very soluble. Hydrochloric acid has no action on either compound.

The juice of the fruit has a specific gravity of 0.01833 at 15° C., and is lævorotatory. It contains a yellow coloring matter which differs from that of the pulp in being soluble in water, insoluble in alcohol, ether, chloroform, and light petroleum, and in not being decolorized by chlorine water or bromine water. The acidity of the juice is said to be due chiefly to citric acid. The juice also contains a small amount of an alkaloid, which, as well as the acid, decreases as the fruit ripens.

The following table shows the percentage composition of the dry matter in the skin, pulp, juice, and seeds:

Composition of different parts of the tomato.

	Water.	Composition of dry matter.			
		Organic matter.	Ash.	Proteids.	Carbohydrates and fat.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Skin	59.50	99.20	0.80	1.85	97.05
Pulp	93.65	89.56	10.44	15.15	74.41
Juice	97.56	74.52	25.48	21.80	*52.72
Seeds	46.30	95.56	4.40	25.40	70.16

* Includes the acid.

The carbohydrates of the skin are chiefly in the form of cellulose.

The following analyses are given of the whole fruit collected in September, 1888, and August, 1889. The first samples were unripe and the second ripe.

Composition of whole tomatoes.

	Unripe fruit.	Ripe fruit.
	Per cent.	*Per cent.*
Moisture at 105° C	93.50	91.01
Composition of dry matter:		
Ash	8.05	12.73
Cellulose	7.83	18.14
Fat and coloring matters	11.73	7.02
Glucose	2.68	41.54
Proteids	11.25	11.48
Citric acid and substances not determined	48.53	9.07

The percentage composition of the ash was as follows:

Potassium oxide	59.46	Phosphoric acid	12.93
Sodium oxide	5.99	Sulphuric acid	3.49
Calcium oxide	1.34	Silica	0.27
Magnesium oxide	3.09	Chlorine	19.14
Ferric oxide	0.22		

In view of the fact that the fruit contains a very large amount of potash and the stems and leaves a large amount of lime (the crude ash of the stems contained 28.32 per cent of lime), the author recommends for tomatoes the use of a fertilizing mixture consisting per acre of about 2¼ tons of barnyard manure, 30 pounds of superphosphate of lime (containing 18 per cent of phosphoric acid), and 55 pounds of muriate of potash (containing 50 per cent of potassium oxide).

Chemical composition and anatomical structure of tomatoes, G. Brissi and T. Gigli (*Staz. Sper. Agrar., 18, pp. 5–34; abs. Jour. Chem. Soc., 60, p. 955*).—The ripe fruit of tomatoes was carefully separated into skin, seeds, and pulp. The pulp formed 85.4 per cent of the whole fruit. The average of several analyses showed it to contain 4.73 per cent of total dry matter, 3.74 per cent of soluble materials, and 1.09 per cent of insoluble materials. The pulp was further separated by filtration through cloth into a red insoluble substance and a yellow liquid, both of which were analyzed. The following table shows the percentage composition (1) of the dry matter of the red insoluble substance, and (2) of the dry matter of the yellow filtrate:

	1	2
Total nitrogen	4.002	2.254
Proteids	25.012	2.430
Coloring matter	21.128	
Cellulose	34.390	
Ash	7.959	10.960
Levulose		46.680
Citric acid		14.030
Amide nitrogen		0.641
Amido-acid nitrogen	1.224	

The percentage composition of the ash of the two products was as follows:

	1	2
Potassium oxide		58.554
Sodium oxide		1.425
Calcium oxide	18.127	1.315
Magnesium oxide	1.423	0.169
Chlorine		8.842
Sulphuric acid		0.781
Phosphoric acid	15.866	7.182
Carbonic acid		18.832
Silica		0.451
Not determined	64.584	2.449

Peanut-hull meal, A. Emmerling (*Landw. Wochenbl. f. Schleswig-Holstein, 41 (1891), p. 516*).—According to the author this material is a refuse from the peanut oil manufacture, and has recently been placed upon the market as a feeding stuff for animals. Analyses of six samples of the meal gave the following results:

Composition of peanut-hull meal.

	Minimum.	Maximum.	Average.
	Per cent.	*Per cent.*	*Per cent.*
Water	7.26	8.58	7.95
Ash	3.83	14.31	10.15
Crude cellulose	48.87	58.96	53.66
Crude fat	3.46	5.65	4.11
Crude protein	7.64	8.97	8.23
Carbohydrates	15.88	16.85	16.33

The coefficient of digestibility for the protein, as indicated by Stutzer's method, was found to be 53.3 per cent in one sample and 46.3 per cent in another.

Time of extraction of paper coils in milk analyses by the Adams method, P. Vieth (*Analyst, 16 (1891), p. 128*).—Tests of the "fat-free" paper, prepared for milk analysis by Schleicher and Schüll, showed it to contain 0.0278 per cent of ether extract, or 0.025 per cent when the paper was moistened with dilute acetic acid and then dried before extraction. The latter indicates the absence of any material of a soapy nature. The average amount of ether extract from a strip weighing 6 grams is therefore 0.0016 gram, which would increase the results of a fat determination by 0.03 per cent, "provided the same amount which is extracted in a blank experiment is also got out after 5 grams of milk have been dried on the paper. I am not at all sure that the latter is the case."

With reference to the length of time the ether extraction of the paper coils containing the absorbed milk is to be continued, the author made the following experiments: Two samples of milk, one of whole and one of skim milk, were extracted for different lengths of time with the following results in per cent of fat:

Time of extraction.	Whole milk.	Skim milk.
1 hour	3.48	0.28
2 hours	3.50	0.30
3 hours	3.54	0.28
4 hours		0.28

In six samples (three of whole and three of skim milk) the number of siphonings as well as the time of extraction was noted, the object being to find out the shortest time required for extracting the fat. The results follow:

	Sample No. 1.			Sample No. 2.			Sample No. 3.			Sample No. 4.			Sample No. 5.			Sample No. 6.		
Number of siphonings	3	6	9	3	5	9	3	6	9	3	6	9	3	6	9	3	6	9
Time (minutes)	17	37	52	19	41	59	13	47	41	24	33	51	22	46	64	15	41	50
Per cent of fat	0.28	0.24	0.28	0.22	0.24	0.24	0.24	0.24	0.26	4.18	4.14	4.24	3.54	3.68	3.68	2.84	2.88	2.90

In the cases of samples 3 and 6 there was little increase in fat after the first three siphonings, occupying only about 15 minutes. In the opinion of the author "continuing the extraction for an hour appears to be more than sufficient for all practical purposes."

A comparison of methods of determining fat in milk, L. F. Nilson (*Chem. Ztg., 15, pp. 619–656*).—The primary object of this study of methods was to test the lactocrite and Soxhlet aerometric methods for the rapid determination of the fat in milk, and to compare their accuracy with that of several gravimetric methods. In the course of the investigation considerable information of interest was brought out with regard to the gravimetric methods most generally in use, and chiefly these will be considered here.

In the tests with the lactocrite a mixture of hydrochloric and lactic acids was used for dissolving the casein, instead of a mixture of sulphuric and glacial acetic acids. Of the gravimetric methods in which the milk is absorbed by some porous substance and dried previous to the extraction of the fat, experiments were made with the following:

(1) Pumice stone prepared by grinding and sifting so as to secure a material the particles of which were not over 1 mm. in diameter, washing with water, and igniting. To about 12 grams of this material in a porcelain dish about 12 grams of milk were slowly added, and the whole dried at 97–98° C., the drying being hastened toward the end by placing in an air-tight oven partially exhausted by a filter pump. The dried residue was collected and placed in a paper cartridge made of the best Swedish filter paper, used double, which had been previously extracted with ether for at least 12 hours. A plug of cotton was placed in the bottom of the cartridge and another in the bottom of the extractor to retain the finer particles of pumice. A Soxhlet extraction apparatus and ether free from alcohol and water were used for the extraction. The objection found to pumice stone as an absorbent was that its pores are too large and do not enable a sufficiently fine distribution of the particles of milk solids. The fat globules remain to some extent inclosed in casein, so that a pulverizing of the dried material before extraction becomes essential to accurate results. This method was discarded after a few tests.

(2) The next material used to absorb the milk was unglazed, lightly burnt earthenware, which was reduced to about the same fineness as the pumice stone and washed on a sieve. This was used in the same manner as the pumice stone, except that about 22 grams of the absorbent were used with 10 grams of milk. Tests were made with whole and skim milk as to the time necessary to complete the extraction of the fat. The use of the double paper cartridge and the cotton made the percolation of the ether somewhat slow and thus lengthened the time necessary for the extraction. It was found that from 3 to 5 hours were sufficient for whole milk, but in the case of skim milk containing 0.85 per cent of fat 5 hours seemed not to be sufficient.

(3) Adams method. Examination of Schleicher and Schüll's "fat-free" paper showed that the strips contained a little over 1 mg. each of material soluble in ether, and that 2 hours were sufficient for extraction of this material. In using this method the milk was poured upon the strip, the strip dried for about half an hour, and then extracted in a Soxhlet apparatus. With regard to the duration of this latter extraction, experiments showed 3 hours to suffice for whole milk, but in his comparisons of the Adams method with others the author extracted for 5 hours in case of whole milk and for 12 hours in case of skim milk. The parallel tests by the Adams method agreed more closely than those by any of the other methods tested.

The averages of parallel results obtained in comparisons of the different methods on the same samples of milk are given as follows:

Percentage of fat in milk by different methods.

	Gravimetric methods.			Lactocrite.	Soxhlet's aerometric method.
	Pumice stone.	Powdered earthenware.	Adams.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Single cow's milk	3.65	3.66	3.74	3.71	3.71
	3.64	3.63	3.73	3.62	3.68
Mixed milk	....	3.09	3.18	3.13	3.18
	2.95*	3.08	....	3.10	....
Single cow's milk	....	2.67	2.76	2.72	2.77
	....	2.55	2.60	2.52	2.56
	....	2.38	2.49	2.43	2.49
Two parts of skim milk and one of whole	....	2.19	2.28	2.23	2.34
Mixed milk 24 hours old	....	1.35	1.43	1.41	1.47
Mixed milk 48 hours old	....	0.85	0.94	0.90	1.02
Centrifugal skim milk	....	0.76	0.86	0.86	1.94
	....	....	0.74	0.69	....
	....	....	0.48	0.42	....
	....	0.31	0.40	....	0.50
	....	....	0.33	0.28	....

* Not powdered after drying.

The differences between the results by the Adams method, the earthenware method, and the lactocrite are expressed in the following statement:

	Maximum.	Minimum.	Average.
Differences between—			
Adams and earthenware	+0.11	+0.05	+0.088
Adams and lactocrite	+0.11	+0.02	+0.052
Lactocrite and earthenware	+0.06	−0.03	+0.035

The author feels certain that the invariably higher results by the Adams than by the earthenware method can not be attributed to the presence of an unaccounted-for ether extract in the paper, and is inclined to the view that owing to the fineness of the interstices of the paper the fat globules are not able to penetrate the paper and so remain on the surface, largely freed from milk serum, where they are more advantageously exposed to the solvent action of the ether.

The powdered earthenware is not required to be extracted with ether previous to use, and can be used over and over again by igniting after use, as the milk ash remaining behind tends to improve it as an absorbent.

(4) Supplementary to these observations the author made a series of tests in which the milk was dried on kaolin. For this purpose very fine particles of kaolin, separated by means of water, were formed into plates, which were baked and afterwards ground to pieces 0.5 to 1 mm. in diameter. Twenty-five grams of this was used with 10 grams of milk, and the operation carried on as with earthenware. The results with whole milk and with skim milk agreed very closely with those obtained by the Adams method. This method is believed to be in every way equal to the Adams, and to present certain advantages over those where other absorbents are used.

As a result of his investigations the author is led to the following conclusions:

(1) The lactocrite, when a mixture of hydrochloric and lactic acids is used, gives results reliable and comparable with those by the best gravimetric methods, whether the milk be rich or poor in fat.

(2) Kaolin prepared as described gives results in close agreement with those by the Adams method.

(3) The Adams method gives thoroughly reliable results, provided the strips of paper are thoroughly extracted with ether before using.

(4) The Soxhlet aerometric method is less reliable than either the Adams or kaolin methods or the lactocrite; with milks containing less than 2.5 per cent of fat it is unreliable, and with milk rich in fat it gives sometimes too high and sometimes too low results.

The curdling of milk during thunderstorms, Tolemei (*Abs. Milch Ztg., 20 (1891), p. 519*).—The author subjected fresh milk to currents of electricity of different intensities, and under varying circumstances, but in no instance did the souring of the milk seem to be hastened. On the contrary the souring seemed rather to be retarded, for while milk which was not treated with electricity was sour in 3 days, the milk treated remained sweet for from 6 to 9 days.

After showing in this manner that the electricity is not the direct cause of the souring, experiments were made on the effect of ozone on milk, in which ozone prepared by the Holtz electric machine was slowly conducted through milk. The milk so treated was found to curdle after a few hours. He concluded that the curdling of milk is therefore not attributable directly to the electricity, but rather to the action of the ozone which is formed by the lightning.

The influence of milk preservatives, A. W. Stokes (*Analyst, 16 (1891), pp. 122–126*).—The author has made a study of the acidity of milk in from 400 to 500 samples. In these investigations the acidity was determined by means of decinormal soda solution, using phenolphthalein as an indicator. His observations led him to believe that

milk as delivered to the London trade is always acid, the acidity being equal on an average to 0.2 per cent of lactic acid.

Such an amount of acidity usually develops in the milk within 8 hours of its coming from the cow. In England, according to the temperature, in from 30 to 40 hours after it has reached an acidity of 0.2 per cent its acidity rises to 0.35 or 0.4 per cent, at which point it has acquired an acid taste and is said to be sour. Usually at an acidity of 0.6 to 0.7 per cent it separates or coagulates. If kept for a long period milk rarely develops a greater quantity of lactic acid than 2 per cent. In some milk, the acidity of which I determined, the highest acidity found was 2.34 per cent after 117 days of keeping. The reason of this is that when this amount of acidity is reached the acid formed is destructive to the fungus forming it. Milk that has not yet developed an acidity of 0.3 per cent but is near it, will coagulate on boiling; it is therefore customary in the trade to test the freshness of a milk, if it is suspected to be stale, by boiling it.

To study the effect of different preservatives on milk not sealed up, a large quantity of the same milk was divided into 11 parts. One part was kept in its original state, another part was boiled, and to the other parts carbonate of soda, potash, salicylic acid, borax, boracic acid, and a mixture of equal parts of borax and boracic acid were added. The acidity was determined in all the samples at intervals of about 4 hours, the sample being thoroughly mixed each time the acidity was determined. In these experiments boracic acid proved the best preservative. When this was used at the rate of two parts per thousand the milk kept sweet for 42 hours longer than milk without any preservative. Boiling milk proved as efficacious as any preservative used at the rate of one part per thousand.

His method of detecting borax in milk is given as follows:

On a porcelain slab place one drop of the milk with two drops of strong HCl and two drops of a saturated turmeric tincture. Dry this on the water bath, take it off directly it is dry, cool, and add a drop of ammonia by means of a glass rod. A slaty blue color changing to green is produced [if borax is present]. I found that a drop of milk containing the thousandth of a grain of borax would give the reaction; even less than this will give the green tint, but not the blue. The turmeric tincture must be fresh, otherwise it is best to use the powdered turmeric.

For rapidly determining the acidity of milk in the trade he recommends the use of compressed pellets containing weighed amounts of carbonate of soda and phenol-phthalein.

In the discussion which followed Dr. P. Vieth said he was quite sure that if the experiments were repeated during the summer and autumn the results would be very different from those obtained by the author from January to May. There was no doubt milk soured much more quickly in summer and autumn, October and November being the most troublesome months. Farmers attributed this to the decaying leaves, and this was perhaps not far from the truth. His own experience was that as soon as an acidity of from 1 to 1.5 per cent was reached fermentation practically ceased, or at any rate proceeded with extreme slowness. With reference to the retarding action of boracic acid on lactic fermentation, other experimenters had not got such good results as Mr. Stokes.

He thought the method proposed for determining the acidity of milk was the most simple, handy, and reliable that could be placed in the hands of the practical cheesemaker.

The occurrence of common salt at different altitudes, A. Müntz (*Compt. rend., 112 (1891), pp. 447–449*).—Rain water collected at high altitudes was found to be very poor in sodium chloride, as is indicated by the following figures:

Rain in high mountains (8,650 feet)	0.34 mg. of salt per liter.	
Rain in low land:		
Bergerac	2.50	Do.
Joinville-le-Pont	7.60	Do.

Water from streams in the Pyrenees contained on an average 0.9 mg. of salt per liter. The author gives the following figures as indicating that plants growing at a high altitude contain much less chlorine than those growing on the plains below, the distance from the sea being the same in both cases:

Percentage of sodium chloride.

	Mountains.	Plains below.
Hay	0.254	1.017
White clover	0.285	0.505
Thyme	0.145	0.238
Rye straw	0.054	0.127

The milk of cows from mountainous regions was found to contain on an average 1.083 grams and that of cows from the lower land 1.35 grams of sodium chloride per liter.

Treatment of apple scab and of grape and gooseberry mildew, J. Craig (*Canada Central Expt. Farm Bul. No. 10, April, 1891, pp. 15*).—Brief popular statements regarding apple scab (*Fusicladium dendriticum*), grape mildew (*Peronospora viticola*), and gooseberry mildew (*Sphærotheca mors-uvæ*), with suggestions regarding the treatment of these diseases. Short accounts are given of experiments under direction of the author with ammoniacal carbonate of copper and other fungicides.

Recommendations for the prevention of damage by some common insects of the farm, the orchard, and the garden, J. Fletcher (*Canada Central Expt. Farm Bul. No. 11, May, 1891, pp. 36, figs. 28*).—General statements regarding insects, means of repression, spraying apparatus, and the preparation and use of various insecticides. Notes are also given on the following insects, with suggestions as to remedies: American frit fly (*Oscinis variabilis*), clover seed midge (*Cecidomyia leguminicola*), Hessian fly (*Cecidomyia destructor*), pea weevil (*Bruchus pisi*), wheat midge (*Diplosis tritici*), wheat stem maggot (*Meromyza americana*), apple aphis (*Aphis mali*), beautiful wood nymph (*Eudryas grata*), cankerworms (*Anisopteryx vernata* and *A. pometaria*),

codling moth (*Carpocapsa pomonella*), fall webworm (*Hyphantria cunea*), flat-headed apple tree borer (*Chrysobothris femorata*), grapevine flea beetle (*Haltica chalybea*), grapevine leaf hopper (*Erythroneura vitis*), imported currant worm (*Ægeria tipuliformis*), imported currant sawfly (*Nematus ribesii*), oyster-shell bark louse (*Mytilaspis pomorum*), pear tree slug (*Selandria cerasi*), plum curculio (*Conotrachelus nenuphar*), raspberry borer (*Oberea bimaculata*), raspberry cane maggot (*Anthomyia* sp.), raspberry sawfly (*Selandria rubi*), raspberry plume moth (*Oxyptilus nigrociliatus*), red-humped caterpillar of the apple (*Œdemasia concinna*), round-headed apple tree borer (*Saperda candida*), tent caterpillar (*Clisiocampa americana* and *C. disstria*), cabbage aphis (*Aphis brassicæ*), cabbage maggot (*Anthomyia brassicæ*), Colorado potato beetle (*Doryphora 10-lineata*), cucumber flea beetle (*Epitrix cucumeris*), cutworms (*Noctuidæ*), imported cabbage butterfly (*Pieris rapæ*), onion maggot (*Phorbia ceparum*), radish maggot (*Anthomyia radicum*), squash bug (*Anasa tristis*), striped cucumber beetle (*Diabrotica vittata*), and turnip flea beetle (*Phyllotreta vittata*).

Corn as a fodder plant, W. Saunders (*Canada Central Expt. Farm Bul. No. 12, June, 1891, pp. 3–15*).—General statements are made regarding the advantages of growing corn for fodder in Canada, time of cutting, selection of varieties, and methods of cultivation and storage. Tabulated data are given for tests of 32 dent, 16 flint, and 41 sweet varieties of corn, together with 2 varieties of pop corn, and for an experiment in planting corn at different distances. The cost of raising and storing corn for silage, as calculated for an experiment at the experimental farm, was about $1.25 per ton.

From the results given it would appear that the Thoroughbred White Flint, Long White Flint, Long Yellow Flint, Yellow Dutton, Large White Flint, Pearce Prolific, and Longfellow are the most productive of the flint varieties, ranging in yield in the order named, and all of them excepting the Long White Flint attained a sufficient degree of maturity to make excellent silage.

Among the different sorts of dent corn, none of which, however, mature as well as the flint varieties, the following have been found to yield the greatest weight of crop: Virginia Horse-Tooth, Golden Beauty, Golden Dent, Blount Prolific, Mammoth Southern Sweet, and Red Cob Ensilage.

Many sorts of sweet corn have given a large yield, the most prolific being Mammoth Sugar, Crosby, Eight-Rowed Sugar, Egyptian Sugar, and Asylum Sweet. The earliest-ripening among these is the Crosby.

Chemical composition of certain varieties of corn, F. T. Shutt (*Canada Central Expt. Farm Bul. No. 12, June, 1891, pp. 16–21*).—Analyses with reference to feeding value are given of samples of Queen of the Prairie, Angel of Midnight, Virginia Horse-Tooth, Golden Beauty, Early Adams, Long White Flint, and Mammoth Southern varieties of corn (whole plant), collected August 26 and September 19; analyses of samples of corn silage taken from the silo December 4 and March 5; and a calculation of the digestible nutrients per ton in each at each

date. The analyses show, with reference to the composition of the corn at different dates, that—

(1) The percentage of water in corn fodder cut August 26 was considerably greater than that in the samples taken September 19.

(2) The percentage of ash in the dry matter decreased materially as the plant matured.

(3) The percentage of albuminoids had decreased slightly in the dry matter during the period of growth between August 26 and September 19.

(4) The percentages of fat, fiber, and carbohydrates had increased during the same period, the two former, however, not to any marked extent.

The analyses of silage show a slight increase in the percentages of protein, fat, and cellulose, and a decrease in carbohydrates from December 4 to March 5.

Report on the progress of the work of the experimental farms of the Dominion of Canada, W. Saunders (*Canada Central Expt. Farm Bul. No. 13, June 2, 1891, pp. 16*).—An outline of the work of the experimental farms during 1890 presented to the Committee on Agriculture and Colonization of the House of Commons of the Dominion of Canada. Details of this work were published in the Annual Report of the experimental farms for 1890.

Variations in the fat of milk drawn from the bottom of the can, H. H. Dean (*Ontario Agr. College Expt. Sta. Bul. No. 66, June 28, 1891, pp. 7*).—These tests were undertaken to determine whether or not, in delivering milk to customers by drawing it through a faucet at the bottom of the can, there is a difference between the milk served first and that drawn last, so that each customer does not get his fair share of fat. Tests were made by the Babcock centrifugal method of the fat in milk drawn by four different milkmen at different intervals during the delivery. The tabulated results show practically no difference in the percentage of fat in the milk drawn from the same can at different times, the variations noted being all within the errors of analysis liable to occur with the method employed.

Winter-wheat experiments, T. Shaw and C. A. Zavitz (*Ontario Agr. College Expt. Sta. Bul. No. 67, August 12, 1891, pp. 12*).—Tests were made of 51 varieties, 24 Canadian and American, and 27 foreign. None of the foreign varieties proved equal to the others. Tabulated data are given for 23 of the Canadian and American varieties.

(1) The bald wheats have given on an average 9.86 bushels or 21.42 per cent more per acre than the bearded varieties, but the latter have weighed on an average 1.37 pounds more per bushel.

(2) The white wheats have given an average of 5.18 bushels more per acre than the red wheats, and they also stand higher in the estimation of the millers than the latter.

(3) The bald white chaff white wheats gave an average of 13.6 bushels per acre more than the bearded red chaff red wheats.

(4) The seven leading varieties in point of yield were all white wheats except the American Bronze.

(5) The four best-yielding white wheats for 1891 were the Garfield [64 bushels per

acre], Surprise [63 bushels], Canadian Velvet Chaff [60 bushels], and Bonnell [59 bushels]; and the four best yielding varieties of red wheat were the American Bronze [65 bushels], Early Red Clawson [58 bushels], Red Velvet Chaff [57 bushels], and Jones Winter Fyfe [56 bushels].

(6) The four best-weighing varieties were the Manchester, Bulgarian, Lancaster, and Democrat, each of which gave 64½ pounds per bushel.

(7) The three Velvet Chaff varieties gave an average yield of 4.77 bushels per acre in excess of the mean average of the 23 varieties, and weighed 0.22 pound more per bushel, and they are also included in the leading varieties mentioned in conclusion (5).

(8) Of the varieties enumerated in this bulletin the Dominion Millers' Association recommend the following as the most serviceable for milling purposes, viz: Of the white wheats, the Surprise, Canadian Velvet Chaff, and Bulgarian; and of the red wheats, Jones Winter Fyfe, Hybrid Mediterranean, and the Longberry Red.

EXPERIMENT STATION NOTES.

ALABAMA COLLEGE STATION.—The office of director has recently been abolished and its duties have been assigned to the president of the board of direction, who is also president of the college. Isaac Ross, A. M. Lloyd, B. S., and W. B. Fraser are no longer members of the station staff.

ALABAMA CANEBRAKE STATION.—The station has recently suffered a severe loss in the death of H. A. Stollenwerck, a member of the governing board and treasurer of the station. A. Sledge of Whitsett, Alabama, has been appointed a member of the governing board vice S. W. John, resigned. Dr. T. J. Kean has been elected veterinarian.

COLORADO STATION.—A revised edition of Bulletin No. 13 on the measurement and division of water was issued July, 1891. Besides numerous changes, principally verbal, some portions of the bulletin have been recast and a few paragraphs have been added.

KANSAS STATION.—H. M. Cottrell, M. S., has accepted a position as farm manager for Vice President Morton. His present address is Rhinecliff, N. Y.

LOUISIANA SUGAR STATION.—J. T. Crawley, B. A., has been appointed chemist to the station vice W. Wipprecht, resigned.

MICHIGAN COLLEGE AND STATION.—Eugene Davenport, M. S., professor of agriculture in the college and agriculturist to the station, has gone to Brazil, where he is to organize an agricultural college in the Province of Sao Paulo. F. J. Niswander, assistant in entomology, has been appointed professor of agriculture in the University of Wyoming. E. A. Burnett, B. S., assistant in agriculture, has been made assistant professor of agriculture. A. B. Peebles, B. S., assistant chemist of the station, has accepted the professorship of chemistry and physics in the Connecticut Storrs Agricultural School. H. J. Hall, B. S., assistant horticulturist, has accepted a professorship in the University of Arizona, and F. B. Mumford, B. S., has been appointed assistant agriculturist to the station.

NEVADA COLLEGE AND STATION.—J. W. Phillips, D. Sc., has given up his connection with the station and has been transferred to the faculty of the university; N. E. Wilson takes his place as chemist to the station. R. H. McDowell, B. S., formerly of the Colorado Agricultural College and Station, has been appointed horticulturist to the Nevada Station. The station is devoting itself largely to experiments in the culture of sugar beets; experiments with tobacco, a new crop for this region, are also in progress.

OHIO STATION.—Under the recent act of the legislature authorizing various counties of the State to raise money by taxation for the purpose of securing the location of the station, the commissioners of Wayne County have submitted to the people of that county a proposition to raise $85,000 for this purpose. This will be voted upon at a special election, and if it should be ratified the station will be located within that county. H. J. Detmers, D. V. M., is no longer a member of the station staff.

VIRGINIA STATION.—The address of C. Ellis, M. D., formerly veterinarian of the station, is at present Springborough, Ohio.

CENSUS BULLETIN NO. 103.—This gives the statistics on horses, mules, and asses on farms, and was prepared by Mortimer Whitehead.

"The figures of the tables show that in the States and Territories there were on hand June 1, 1890, 14,976,017 horses, 2,246,936 mules, and 49,109 asses; that in 1889 there were foaled 1,814,404 horses, 157,105 mules, and 7,957 asses; that there were sold in the same year 1,309,557 horses, 329,995 mules, and 7,271 asses; and that there died from all causes 765,211 horses, mules, and asses during the same period.

"The increase of horses from 1880 to 1890 is shown to be 44.59 per cent, as against 44.95 per cent between 1870 and 1880, and 14.34 per cent between 1860 and 1870. The increase of mules from 1880 to 1890 was 26.66 per cent; between 1870 and 1880 the increase was 61.08 per cent, while from 1860 to 1870 there was a decrease of 2.24 per cent.

"Of the aggregate number of horses and mules in the whole country June 1, 1890, 86.95 per cent were horses and 13.05 per cent were mules. The North Atlantic group of States had the smallest proportion of mules—2.41 per cent, while the South Atlantic group had the largest proportion—32.04 per cent, as against 67.96 per cent of horses."

CENSUS BULLETIN NO. 111.—This is the first report ever made through the Census Office of the statistics of the seed farms of the United States. The bulletin was prepared by J. H. Hale. Only such farms as were devoted to seed growing as a business are included.

The report shows "a total of 596 farms in the United States devoted exclusively to seed production. These farms occupy 169,851 acres of land, of which 96,567½ acres were reported as devoted to seed production during the census year, divided as follows: 1,437 acres of asparagus, 12,905 of beans, 919 of beets, 1,268 of cabbage, 569 of carrots, 11 of cauliflower, ½ of celeriac, 71 of celery, 13 of collards, 1½ of corn salad, 15,004 of sweet corn, 16,322 of field corn, 1½ of cress, 10,219 of cucumbers, 39¾ of dandelion, 252 of egg plants, 16 of endive, 105 of kale, 19 of kohl-rabi, 13½ of leek, 486½ of lettuce, 5,149 of muskmelons, 3,978 of watermelons, 2 of nasturtium, 13 of okra, 3,560 of onions, 352 of onion sets, 75 of parsley, 374 of parsnips, 7,971 of peas, 365 of peppers, 4,102 of potatoes, 105 of pumpkins, 662 of radishes, 25 of rhubarb, 26 of salsify, 150 of spinach, 4,356 of tomatoes, 885 of turnips, 4,663 of squashes, and 81 of flower seeds. [This industry represents a total value of farms, implements, and buildings of $18,325,935, and employed in 1890 13,500 men and 1,541 women.] * * * Of the 596 seed farms in the United States, 258, or nearly one half, are in the North Atlantic division, the original center of seed production. These farms have an acreage of 47,813, or an average of 185 acres per farm, while in the north-central division there are 157 farms with an acreage of 87,096, or an average of 555 acres per farm. The seed farms of Massachusetts and Connecticut average 142 acres per farm, while those of Iowa and Nebraska are 695 acres in extent, and are producing seeds on a scale of equal magnitude to the other products of that section of the country. Several of these seed-producing farms embrace nearly 3,000 each. * * * So far as reported there were but 2 seed farms in the country previous to 1800 (one of these was established in Philadelphia in 1784, and the other at Enfield, New Hampshire, in 1795), only 3 in 1820, 6 in 1830, 19 in 1840, 34 in 1850, 53 in 1860, 100 in 1870, 207 in 1880, and 200 more were established between 1880 and 1890, leaving 189 unaccounted for as to date of establishment."

AMERICAN POMOLOGICAL SOCIETY.—The twenty-third biennial session of this society was held at Washington, September 22–24, 1891. Papers were presented on the following subjects: Results of Recent Experiments with Small Fruits, T. T. Lyon, South Haven, Michigan; How to make Small-Fruit Culture Pay, J. H. Hale, South Glastonbury, Connecticut; New and Promising Small Fruits, J. T. Lovett, Little Silver, New Jersey; Recent Progress in the Treatment of Diseases of Pomaceous Fruits, B. T. Galloway, U. S. Department of Agriculture; Chemistry of Peach Yellows, E. F. Smith, U. S. Department of Agriculture; Pruning for Citrus and other Fruits for Florida, D. W. Adams, Florida; Fertilization, Crossing, and Hybridization of Plants, C. E. Bessey, University of Nebraska; Immediate Effects of Cross-Fertilization as Affecting Quality and Commercial Value of Citrus Fruits, Lyman

Phelps, Sanford, Florida; Heredity and Environment in Originating New Fruits, Thomas Meehan, Germantown, Pennsylvania; Fruit Districts Geologically and Climatically Considered, E. S. Goff, experiment station, Madison, Wisconsin; Recent Advance in Dealing with Insects Affecting Fruits, C. V. Riley, U. S. Department of Agriculture; Does the Spraying of Orchards with Insecticides pay? C. M. Weed, College of Agriculture, Hanover, New Hampshire; Some Local Pomological Problems, Charles W. Garfield, Michigan; Pomology in the Eleventh Census, Mortimer Whitehead, U. S. Census Bureau; Apple Growing Commercially Considered, F. Wellhouse, Fairmont, Kansas; Commercial Peach Growing, J. F. Taylor, Douglas, Michigan; Section *vs.* Whole Roots in Propagating the Apple, J. L. Budd, Ames, Iowa; Novelties in Pomology, H. E. Van Deman, U. S. Department of Agriculture; General Fruit Growing, G. C. Brackett, Lawrence, Kansas; Fruit Notes from a Canadian Standpoint, L. Wolverton, Grimsby, Ontario; The Grapes of Middle Virginia, Henry L. Lyman, Charlottesville, Virginia; Small-Fruit Growing in Eastern and Middle North Carolina, J. Van Lindley, Pomona, North Carolina; Pomological Resources of North Carolina, W. F. Massey, College of Agriculture, Raleigh, North Carolina; Pear Blight and Climate Influences, G. F. B. Leighton, Norfolk, Virginia; The Rooted Cutting System of Transplanted Trees, H. M. Stringfellow, Hitchcock, Texas; Fruits of Western North Carolina, H. S. Williams, Rockledge, Florida; Judging Citrus Fruits, J. E. Cutter, Riverside, California.

FOREIGN PUBLICATIONS.—In a recently published article on *Feeding Experiments at the North American Experiment Stations** Dr. Martin Wilckens, who visited a large number of the stations in this country during 1888 as a representative of the Austrian Government, discusses the silage system of the United States and Canada, and gives quite full abstracts of the work done at the Illinois, Kentucky, Massachusetts, Michigan, Minnesota, Missouri, Mississippi, New York (State and Cornell) Ohio, Pennsylvania, Tennessee, Texas, Vermont, Virginia, and Wisconsin Stations on the preparation, composition, and feeding value of corn silage, and makes brief mention of experiments in other lines at the New Hampshire, Iowa, Maine, Michigan, and Mississippi Stations. He believes the teachings of many of these investigations to be applicable to the conditions prevailing in Europe.

The tenth revised and considerably enlarged edition of Prof. Julius Kühn's work on feeding—*Die zweckmässigste Ernährung des Rindviehs*—has recently been issued at Dresden.

The Office has received through the Department of State from W. D. Warner, United States Consul at Cologne, Germany, a copy of a work entitled *Die Düngung der wichtigsten tropischer Culturpflanzen*, by Dr. A. Stutzer, director of the experiment station at Bonn.

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*Jour. f. Landw., 39, pp. 17–35.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING SEPTEMBER, 1891.

DIVISION OF ENTOMOLOGY:

Periodical Bulletin, vol. III, Nos. 11 and 12, August, 1891.—Insect Life.

DIVISION OF STATISTICS:

Report No. 88 (new series), September, 1891.—Report on Condition of Crops in America and Europe; Freight Rates of Transportation Companies.

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Bulletin vol. VII, No. 1.—Journal of Mycology.

BUREAU OF ANIMAL INDUSTRY:

Special Report on the Cause and Prevention of Swine Plague.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Record, vol. III, No. 2, September, 1891.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS.

DURING SEPTEMBER, 1891.

ARKANSAS AGRICULTURAL EXPERIMENT STATION:

Third Annual Report, 1890.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 109, August, 1891.—Fertilizers.

STORRS SCHOOL AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 7, September, 1891.—Chemistry and Economy of Food.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF ILLINOIS:

Bulletin No. 17, August, 1891.—Experiments with Wheat, 1890–91; Daily Variations in Milk and Butter Production of Cows.

AGRICULTURAL EXPERIMENT STATION OF INDIANA:

Bulletin No. 36, August, 1891.—Field Experiments with Wheat; Testing Grain; Wheat Scab; Forms of Nitrogen for Wheat.

IOWA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 14, August, 1891.—Effect of Food upon the Quality of Milk; Calf-Feeding Experiment; A Feeding Experiment for Milk; Pig-Feeding Experiment; Reports on Entomological Work; Breeding of Orchard and Garden Fruits; An Aphthous Affection Among Dairy Cows of the State.

KANSAS AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 20, July, 1891.—Experiments with Wheat.

Bulletin No. 22, August, 1891.—Smut of Oats in 1891; Test of Fungicides to Prevent Loose Smut of Wheat; Spraying to Prevent Wheat Rust.

KENTUCKY AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 34, August, 1891.—Commercial Fertilizers.

Bulletin No. 35, September, 1891.—Experiments with Wheat and Oats.

MAINE STATE COLLEGE AGRICULTURAL EXPERIMENT STATION:

Annual Report, part IV, 1890.

MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 41, September, 1891.—Weather Record, July and August, 1891; Analyses of Commercial Fertilizers; Feeding Experiments with Milch Cows.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:

Meteorological Bulletin No. 32, August, 1891.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF MINNESOTA:

Bulletin No. 16, April, 1891.—Sheep Scab and How to Cure it.

Bulletin No. 17, August, 1891.—Migratory Locusts in Minnesota in 1891.

Bulletin No. 18, September, 1891.—Notes on Strawberries, Raspberries, Sand Cherries, Buffalo Berries, and Russian Mulberries; Evergreens from Seed; Summer Propagation of Hardy Plants.

NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS:

Annual Reports, 1890.

AGRICULTURAL EXPERIMENT STATION OF NEW MEXICO:

Bulletin No. 3, June, 1891.—A Preliminary Account of some Insects Injurious to Fruits.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 29, July, 1891.—Cream Raising by Dilution; The Effect of Delay in Setting on the Efficiency of Creaming; Application of Babcock Centrifugal Method to the Analysis of Milk, Skim Milk, Buttermilk, and Butter; The Relation of Fibrin to the Effectual Creaming of Milk.

Bulletin No. 30, August. 1891.—Some Preliminary Studies of the Influence of the Electric Arc Lamp upon Greenhouse Plants.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 75, April 15, 1891.—Fertilizers.

Bulletin No. 79, July 20, 1891.—Facts for Farmers.

OHIO AGRICULTURAL EXPERIMENT STATION:

Bulletin vol. IV, No. 3 (second series), August 1, 1891.—Commercial and other Fertilizers on Wheat.

Bulletin vol. IV, No. 4, August 25, 1891.—Experiments in Wheat Seeding, including Treatment of Seed for Smut; Comparative Test of Varieties of Wheat.

RHODE ISLAND STATE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 10, May, 1891.—Mixed Foods in Cases of Faulty Appetite in Horses and Neat Stock; Patented and Proprietary Foods; Sore Shoulders in Horses.

VERMONT STATE AGRICULTURAL EXPERIMENT STATION:

Fourth Annual Report, 1890.

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EDITORIAL NOTES.

The annual meeting of the German Association for the Advancement of Science (*Gesellschaft deutscher Naturforscher und Aerzte*) was held in Halle, September 21–25, 1891. This Association was organized in 1822. It includes thirty-two sections, of which ten may be reckoned as representing general mathematical and physical science, and twelve as more especially relating to medicine and surgery. The Halle meeting was the sixty-fourth in the history of the Association. The number of members and associates (*Theilnehmer*) in attendance was reported as about 1,300, and included many of the leading scientific men of Germany and a number from other countries. Addresses of general interest were delivered at the general sessions, and many papers representing the latest and best research in special lines were presented and discussed at the meetings of the several sections. The next year's meeting is to occur in Nuremberg.

The sessions of the Section for Agricultural Chemistry and Agricultural Research (*Abtheilung für Agrikulturchemie und landwirtschaftliches Versuchswesen*) were of marked interest. Among the well-known German investigators present were von Wolff, Nobbe, G.Kühn, Stohmann, Wagner, Stutzer, Maercker, Hellriegel, H. Schultze, König, Dietrich, Orth, Emmerling, and Bretschneider. Among the foreign guests were Dr. Gilbert of Rothamsted, England; Professor Mayer of Wageningen, Holland; Professor Kellner of Tokio, Japan; and Professor Atwater of the United States.

The intervals between the sessions gave opportunity to visit the experiment station of the Central Agricultural Society of the Province of Saxony, Prussia, and the Agricultural Institute of the University, with its laboratory of vegetable physiology and experiment station (*Versuchsanstalt*). The station of the provincial society, commonly known as the Halle Experiment Station, has no official connection with the institute or its station, although Professor Maercker, the director of the Halle Station, is professor in the institute. The experimental work of the institute is largely in the study of diseases of plants.

One day of the session was devoted to the meetings of the Association of Experiment Stations in the German Empire (*Verband landwirthschaftlicher Versuchs-Stationen im deutschen Reiche*). (See Experiment Station Record, vol. I, page 175.) This Association is similar in purpose, organization, and operations to the American Association of Official Agricultural Chemists. It differs from that, however, in that it concerns itself more with the ways of introducing and executing the control of the commercial products investigated. The difference is explained by the fact that a large number of stations are engaged in this control, and that it is exercised almost exclusively by them, while in the United States but few stations perform such work, much of it being done by State boards, commissioners, and inspectors. It is an especial object of this Association (of which 44 of the German stations are members) to secure uniformity of methods of investigation, and efficiency in the control of fertilizers, feeding stuffs, and seeds. Comparatively little time was given to the discussion of methods of analysis at the Halle meeting, as other important matters, especially in connection with the conditions under which analyses of fertilizers should be made, called for detailed consideration.

In the meetings of the Section of Agricultural Chemistry a considerable number of papers and informal reports were presented and discussed.

The Dresden Experiment Station for Plant Culture, established April 1, 1890, by the Saxon Government, and located in the Dresden Royal Botanic Garden, was described by Professor Drude, director of the Botanic Garden and superintendent of the horticultural division of the station, and Dr. Steglich, superintendent of the agricultural division of the station. The description was of special interest as illustrating the ways in which the managers, with the advantage of the latest and best experience, have planned the appliances and work of the station. Unlike the majority of the German stations, this is supported and controlled entirely by the Government. It has the same governing board as the station at Tharand. As that station, of which Professor Nobbe is director, was not provided with the desired land for garden and field experiments, and the Dresden Botanic Garden as newly organized included ample ground, an area of about 8.75 acres (3.5 hectares) was assigned to the new station. Buildings, including botanical and chemical laboratories, are being erected. An area of 2.8 acres (1.12 hectares) has been laid out in plats for experiments on varieties, effects of fertilizers, and diseases of plants and their prevention. One peculiar feature of the plat experiments is the plan for tests with typical soils of Saxony. For this purpose the soil of a measured area is removed to the depth of one meter and replaced by the special soils for experiment, which are brought from appropriate localities. An apparently uniform sandy or gravelly subsoil is thought to promise uniform drainage and water supply from below. While these experiments are being made at the

station, others on similar small plats are to be carried out in accordance with the same schedules by farmers in different parts of Saxony under the direction of the station. Experiments in which the effects of fertilizers and kindred questions are to be studied under circumstances which provide for uniformity of soil, regulation of moisture, collecting of all drainage water for analysis, determination of meteorological conditions, and physical and chemical study of the soil, and of course accurate measurement and other desired examinations of the produce, are also to be made in boxes of one cubic meter content. These are made of cement, lined with glass, the joints of which are closed with red lead, and are furnished with tubes at the bottom by which water may be supplied or removed, and the water table kept at any desired level.* These boxes are surrounded by soil of the same character as that contained in them, in order to make the temperature correspond with that of the soil in its natural condition. Deep passageways between the rows of boxes make the management of the drainage tubes easy. Long thermometers running horizontally at different depths through the side of a similarly situated box of soil, serve for observations of soil temperatures.

Dr. Wohltmann of the Agricultural Institute of the University of Halle described a series of experiments conducted by himself and Dr. Scheffler during 3 successive years in boxes somewhat similar to those above described. The object was to study the effects of fertilizers containing nitrogen, phosphoric acid, and potash, singly and in combination, upon the growth of different plants, and the gain and loss of plant food by the soil under conditions at once normal and capable of measurement and control. The paper was an abstract of a memoir just published,† and not only gave the plan and results of the experiments, but discussed the experimental method, which is a modification of that proposed by Prof. P. Wagner. Summaries of this and other papers presented at the meeting will be published in the Experiment Station Record.

Dr. Gerlach of the Halle Experiment Station described several sets of experiments which were instituted as part of a series, the object of which is to work out a laboratory method for determining the deficiencies of soils in plant food. Attention was first given to phosphoric acid. In these experiments the effort is being made to find a solvent which will extract from the phosphoric acid of different soils quantities similar to those which plants can utilize and thus afford an approximate measure of the available as distinguished from the total amount of

* In visiting this station in company with the writer, Dr. Gilbert of Rothamsted referred to the difficulty experienced there in getting boxes which will not leak, and in filling them satisfactorily with earth. After trials with different materials glazed earthenware was finally decided upon.

† Berichte a. d. physiol. Laboratorium und d. Versuchsanstalt d. Landw. Instituts d. Univ. Halle, 8, 1891.

phosphoric acid in the soil thus treated. Plants were grown in cylindrical pots (Wagner's) containing samples of the soils to be studied. The effect of phosphatic fertilizers, as measured by the increase of yield when they were applied, was compared with the amounts of phosphoric acid extracted by acetic, tartaric, oxalic, and citric acids and their salts. From several hundred experiments which have been conducted during 2 years with some sixteen typical soils, it appears that a 1 per cent solution of citric acid generally serves to indicate the amount of phosphoric acid available to plants. There are, however, exceptions which are not yet explained. In the course of the discussion of the paper, Professor Orth of Berlin, whose studies of soils are well known, remarked upon the need of detailed study of the physical and geological characters of the soil, and of the physiological habits of the plants as well. It was explained both by Dr. Gerlach and by Professor Maercker that the results thus far obtained are regarded as tentative, and no final conclusions are yet made. They hope, however, by their studies, which embrace not only the geological, physical, and chemical characters of the soils, but also their agricultural characters as shown by past and present experience and experiment, to work out a reliable method for such soil analysis as they are now attempting. They contemplate extending the inquiry to other soil elements of plant food, as potash and nitrogen. Incidentally Professor Maercker stated that the Wagner method of pot culture had proven very satisfactory. Parallel experiments had been made in ordinary earthen pots with results which agreed in the main with those obtained in the Wagner cylinders.

Another line of study with reference to the needs of soils and the feeding capacities of plants, namely, the growing of plants with different fertilizers and analyzing the produce, was presented in a paper by Professor Liebscher of the Agricultural Institute of the University of Göttingen. This gave the results of a series of experiments which have been in operation for several years in the experimental garden of the institute. Different plats of land were treated with nitrogen, phosphoric acid, and potash compounds, singly, two by two, and all three together. In the crops which grew upon them the quantities of the same elements were determined. Although the results thus far obtained do not warrant broad generalizations, Professor Liebscher hoped that such would be obtainable by further prosecution of the inquiry.

Professor Hellriegel addressed the meeting upon quantitative vegetation experiments and individual factors of growth. He laid special stress upon the importance of having the conditions of experiment under control, and so regulating them that while the particular factor in question should be adapted to the purpose of the experiment, all the others should be favorable. In this way and in this way alone can exact studies of the effects of individual factors be made. He dwelt

upon the errors and evils which result from neglect to observe this principle, and at the same time pointed out the great difficulties in observing it properly. He also urged the danger of hasty inferences and the need of repeating experiments.

Dr. Morgen of the Halle Station cited the results of extended experience and experiment in the detection of adulterants, especially Redonda phosphate, in Thomas slag. The determination of loss on ignition is often helpful, a loss of 0.5 to 1 per cent indicating adulteration. The specific gravity method of Loges is also valuable, but instead of potassio-mercuric iodide solution for detecting Redonda phosphate, Dr. Morgen recommended bromoform (sp. gr. 2.9). The method of Richter for separating Redonda phosphate from Thomas slag by dilute soda solution is excellent. Five per cent solution of citric acid dissolves Thomas slag, but not Redonda phosphate. The method of Jantsch and Schucht is one of the best for quantitative determinations of Thomas slag.

Dr. Cluss of the Halle Station cited some interesting experiments on the use of hydrofluoric acid as an antiseptic in the manufacture of alcohol. It prevents souring and promotes the fermentative action of yeast in a very marked degree.

Dr. Wilfarth of the station at Bernburg described a germination apparatus for testing seeds, especially of sugar beets. It consisted of a brass sieve, the bottom of which was covered with muslin. On this were placed the seeds and over them another piece of muslin was laid. This latter was covered by a layer of sand, which was kept moist.

Professor Drude of Dresden and others gave the results of experience with fungicides on potatoes affected by *Peronospora viticola*.

A paper which excited especial interest was one by Dr. Gilbert on root tubercles and the fixation of atmospheric nitrogen by plants. It was a preliminary notice of methods and results of a large number of experiments at Rothamsted with annual and perennial legumes grown in sterilized sand and in rich soil, without nitrogenous fertilizers, and with and without inoculation by microbe seeding. A number of photographs showed the development of the plants and of the root tubercles. The inoculated plants had abundant root tubercles, grew vigorously without nitrogenous fertilizers, and gained large quantities of atmospheric nitrogen. The connection between this acquisition and the root tubercles was perfectly evident, thus confirming observations of other experimenters. Especial attention was called to the development of root tubercles at different periods of growth of the plants and to marked differences between the annuals and perennials. The author has furnished an abstract for the Experiment Station Record.

In the discussion which followed the reading of Dr. Gilbert's paper, Professor Hellriegel, who was the first to show the connection between the root tubercles and the fixation of nitrogen and whose results it was one purpose of Messrs. Lawes and Gilbert's experiments to confirm,

cited some of his own observations on the root tubercles, and urged that a great deal of experimental study would be needed before their nature and action would be fully understood. To illustrate the practical applications to be made of the information already gained, he cited some instances of notable increase of leguminous crops, which had been effected by spreading sand or other soil from fields where legumes had flourished in small quantities over ground where the same legumes were to be grown. This is simply a practical application of the methods of inoculating the roots with tubercle microbes, which have brought such remarkable results in experiments on a small scale. Science has thus far taught that the chief uses of tillage and manuring are to regulate the moisture and temperature of the soil and to provide proper food for the plants grown upon it. This reveals another means for increasing the growth of our crops, namely, the furnishing of bacteria to enable the plants to provide themselves with nitrogen from the air.

By request, Professor Atwater of this Office gave an account of the agricultural experiment station enterprise in the United States.—[W. O. A.]

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Connecticut State Station, Bulletin No. 109, August, 1891 (pp. 40).

FERTILIZERS.—Tabulated analyses are given of 57 samples of nitrogenous superphosphates and 38 samples of special manures collected during the present year, and of 19 home mixtures.

Of the 57 brands [of nitrogenous superphosphates] here reported, 14 are below their minimum guaranty in respect of one ingredient, and 6 in respect of two ingredients. That is, one third of all the nitrogenous superphosphates in our market contain less of one or of several ingredients than they are claimed to contain. * * *

[Of the 38 special manures] 11 brands are below the maker's guaranty in respect of one ingredient, 2 in respect of two ingredients, and 1 brand is below in all three. * * * A comparison of the average composition of these special manures with that of the other nitrogenous superphosphates shows the former to contain on the whole considerably more nitrogen, nearly twice as much potash, and somewhat less phosphoric acid than the latter. * * *

Comparing the home mixtures with the special manures it is seen that the former contain on the average (14 analyses) half of 1 per cent more nitrogen, over 1.5 per cent more phosphoric acid, and slightly more potash than the latter.

The average cost of the materials of which these mixtures were made, delivered, was $34.82. To this must be added the cost of screening and mixing. * * * If the average cost of the mixed materials is placed at $37 per ton it will probably fully cover all expense in every case.

On this basis of averages the home mixtures, containing considerably more of both nitrogen and phosphoric acid and slightly more potash than the special manures, have cost $37 per ton, or 6.2 per cent more than the station's valuation of the ingredients; the special manures have cost $38.70, or 23.7 per cent more than the station's valuation; and the nitrogenous superphosphates, which contained considerably less nitrogen and about half as much potash but somewhat more phosphoric acid than the special manures, have cost $33.97, or 26.7 per cent more than the station's valuation.

Connecticut Storrs Station, Bulletin No. 7, September, 1891 (pp. 16).

CHEMISTRY AND ECONOMY OF FOOD, W. O. ATWATER, PH. D., AND C. D. WOODS, B. S.—This is a brief résumé of the results of inquiries carried on by the authors for a number of years. Detailed accounts of these investigations will be published in the Annual Report of the station for 1891. Besides general explanations regarding the chemical composition and digestibility of foods, and the principles of food economy, the bulletin contains seven tables with data as follows:

(1) Percentages of nutrients, water, and refuse, and estimated potential energy in specimens of food materials (animal and vegetable) as purchased; (2) percentages of nutrients, water, etc., and estimated potential energy in the edible portion of specimens of food materials; (3) digestibility of nutrients of food materials; (4) proportions of nutrients digested and not digested from food materials by healthy men; (5) standards for daily dietaries for people of different classes; (6) nutrients and potential energy in dietaries of different people; (7) amounts of nutrients furnished for 25 cents in food materials at ordinary prices. The potential energy of the nutrients is estimated in Calories. "The chemical composition of foods is compiled from American analyses, the digestion experiments are wholly European, and the dietaries are both American and European. * * * Not far from fifty dietaries of several hundred people in private families and boarding houses, mostly in New England, have been collated, and the chemical analyses of quite a large number of animal foods—meat, fish, oysters, and the like—have been made in the chemical laboratory of Wesleyan University and by this station since 1880."

Standard vs. actual daily dietaries for people of different classes.

[100 grams = 3.5 ounces or 0.22 pounds. 1 ounce = 28.35 grams. 1 pound = 453.6 grams.]

	Nutrients.				Potential energy of nutrients.
	Protein.	Fat.	Carbohydrates.	Total.	
Standards for daily dietaries.					
Voit *et al*:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Cal.*
Children, 1 to 2 years (German)	28	37	75	140	765
Children, 2 to 6 years (German)	55	40	200	295	1,420
Children, 6 to 15 years (German)	75	43	325	443	2,040
Aged woman (German)	80	50	260	390	1,860
Aged man (German)	100	68	350	518	2,475
Woman at moderate work (German)	92	44	400	536	2,425
Man at moderate work (German)	118	56	500	674	3,055
Man at hard work (German)	145	100	450	695	3,370
Playfair:					
Man with moderate exercise (English)	119	51	531	701	3,140
Active laborer (Eglish)	156	71	568	795	3,630
Laborer at hard work (English)	185	71	568	824	3.750
Atwater:					
Woman with light exercise (American)	80	80	300	460	2,300
Man with light exercise (American)	100	100	360	560	2,815
Man at moderate work (American)	125	125	450	700	3,520
Man at hard work (American)	150	150	500	800	4,060
Actual dietaries in United States and Canada.					
French-Canadian working people in Canada	109	109	527	745	3,620
French-Canadians, factory operatives, in Massachusetts	118	204	549	871	4,630
Other factory operatives, mechanics, etc., in Massachusetts	127	186	531	844	4,430
Glass blowers, East Cambridge, Massachusetts	95	132	481	708	3,590
Factory operatives, boarding house, Massachusetts	114	150	522	786	4,000
Well-to-do private family, Connecticut — food purchased	129	183	467	779	4,145
Well-to-do private family, Connecticut — food eaten	128	177	466	771	4,080
College students from Northern and Eastern States, boarding club, two dietaries, same club — food purchased	161	204	680	1,045	5,345
— food eaten	138	184	622	944	4,825
— food purchased	115	163	460	738	3,875
— food eaten	104	136	421	661	3,415
College football team, food eaten	181	292	557	1,030	5,740
Mechanics (machinists), Connecticut	105	147	399	651	3,435
Machinist, Boston, Massachusetts	182	254	617	1,053	5,640
Teamsters, marble workers, etc., at hard work, Massachusetts	254	363	826	1,443	7,805
Brickmakers, Massachusetts	180	365	1,150	1,695	8,850
U. S. Army ration	120	161	454	735	3,850
U. S. Navy ration	143	184	520	847	5,000

Illinois Station, Bulletin No. 17, August, 1891 (pp. 16).

EXPERIMENTS WITH WHEAT, 1890–91, G. E. MORROW, M. A. (pp. 1–9).—A record of experiments in continuation of those of previous years, reported in Bulletin No. 11 of the station (see Experiment Station Record, vol. II, p. 273). The topics treated are (1) quantity of seed, (2) time of sowing, (3) depth of sowing, (4) effect of fertilizers, (5) test of varieties. With the exception of some of the fertilizer tests, the experiments were made on the fertile, dark-colored prairie soil of the station farm. The season was unusually favorable for wheat.

Wheat, quantity of seed.—Notes and tabulated data are given for an experiment on seven plats, 2 by 4 rods each, seeded at the rate of from 3 to 8 pecks per acre.

Trials for 3 years indicate that variations in quantity of seed between 1 and 2 bushels per acre have less effect on yield than other conditions have. In 1891 the largest yield was from 6 pecks per acre; in 1890, from 4 and from 8 pecks; in 1889, from 5 pecks.

In 1891 sowing small kernels gave a larger yield than was obtained from the same weight of larger kernels, but less than from the same number of larger kernels. The kernels in the crop from the small seed were approximately as large as those from the larger seed.

In two trials no injury resulted from rolling drilled wheat soon after sowing.

Wheat, time of sowing.

The yields of five plats, sown at intervals of 10 or 12 days from September 2 to October 14, were all good [30.8–36.4 bushels per acre]. It is not certain that they were affected by the date of sowing. If the last-sown plats be excepted, there was no appreciable difference in time of ripening, and very little including it. The quantity of straw and the number of stalks per square foot decreased from the earliest to the latest sowing. The average length of heads and weight of kernels increased from the first to the last, except in the case of the second sowing, which was better than the third. In view of danger from the Hessian fly and of undue growth of straw, very early sowing is not advisable; and the danger to late-sown wheat from repeated freezing in winter or early spring makes it unsafe in this latitude to sow in October.

Wheat, depth of sowing.—"September 27, 1890, in each of nine rows 1 rod long and 1 foot apart, 198 kernels of selected seed wheat were planted. This is one kernel for each inch." In each plat of three rows the wheat was covered 1 inch, 3 inches, or 5 inches. The yields diminished with the increased depth of planting.

Wheat, effect of fertilizers.—Notes and tabulated data are given for experiments with commercial fertilizers and barnyard manure at the station and in four other localities in Illinois. At the station the yields where commercial fertilizers were used and the yields in 1891 on plats where commercial fertilizers had been applied in large amounts in 1889, averaged somewhat less than those on unfertilized plats. The results of all the trials with commercial fertilizers on wheat at the station indicate that such fertilizers are not profitable on the black prairie soils of central Illinois.

Trials at Flora, Odin, and Nashville show a marked increase in yield from use of barnyard manure; those at Odin and Nashville, some increase from the use of superphosphate of lime, but in general not enough to make its use profitable. At Belleville neither barnyard manure nor superphosphate produced any considerable percentage of increase in yield. At Flora the plats with superphosphate yielded less than those without any fertilizer. In view of the results in former years, trials on a small scale with superphosphate of lime and cattle tankage are recommended for wheat on the light-colored soils of southern Illinois. The value of barnyard manure for these soils can hardly be overestimated.

Wheat, test of varieties.—A brief report is given on tests of 12 varieties of English cross-bred wheat and of 2 varieties from France. The indications were that with perhaps two or three exceptions these varieties would mature too late to be desirable for Illinois. Campbell's White Chaff wheat, a spring variety from Canada, did not give promising results at the station.

DAILY VARIATIONS IN THE MILK AND BUTTER PRODUCTION OF COWS, E. H. FARRINGTON, M. S. (pp. 9–16).—Diagrams are given which graphically represent the variations in the yield of milk and in percentage and amount of butter fat from day to day for each of two cows, the variations in the night's and morning's milk of one cow, and the daily variations in the mixed milk of three cows for periods of from 40 to 66 days, together with the daily variations in temperature. These diagrams show for the cows under trial, the food and general conditions remaining constant, that, (1) there were usually very considerable changes in the yield of milk of the individual cows, and the percentage of butter fat in the same from day to day; (2) cows receiving the same food differed from each other as to the amount of this variation; (3) the variations from day to day in the morning's and evening's milk considered separately were greater than in the mixed milk for the day; (4) the mixed milk of several cows was more uniform in amount and in quality than the milk of individual cows; and (5) "as a rule the number of pounds of milk was low when the mean daily temperature was high and the number was high when the temperature was low." It was noticed in the case of one cow that "when she gave a small mess of milk it had a per cent of butter fat below her average, and the largest milkings were of her richest milk." The maximum, minimum, and average daily yields of milk and of butter fat from May 1 to August 1 are also tabulated for each of six cows.

Iowa Station, Bulletin No. 13, May, 1891 (pp. 120).

EXPERIMENT IN FEEDING FOR MILK, J. WILSON, G. E. PATRICK, M. S., C. F. CURTISS, B. S. A., E. N. EATON, B. S., AND D. A. KENT, B. S. (pp. 5–30).—This trial was made with eight cows and was designed to test the relative feeding value of corn fodder, corn silage, sorghum silage, and mangel-wurzels. Each of these coarse fodders was fed during a period of 10 days, the intervening transition periods being

5 days each. The silage and corn fodder were fed *ad libitum*, from 40 to 45 pounds of roots were fed per animal, the grain rations were different for each cow, and clover hay was fed with each of the coarse fodders in varying amounts. Data as to the amount of each food consumed and the yield and composition of the milk are tabulated for each cow, and summaries are given for the eight cows on each coarse fodder. In the case of four of the cows the production of milk and of butter fat was largest when roots were fed; two others gave the largest yield with corn fodder, and two with corn silage. About twice as much clover hay was fed with the roots, however, as with either of the other coarse fodders. It is obviously impossible to gain an idea of the real effect of the different coarse fodders. The financial side of the question is not considered and the cost of the different feeding stuffs is not given.

TREATMENT OF FUNGOUS DISEASES, L. H. PAMMEL, B. AGR. (pp. 31–71, plates 10, figs. 16).—General explanations of fungous diseases of plants and their treatment, formulas for various copper solutions, descriptions of spraying apparatus, and original and compiled notes on the nature and treatment of apple rust (*Rœstelia pirata*), pear leaf blight (*Entomosporium maculatum*), plum rust (*Puccinia pruni-spinosæ*), spot diseases of currants (*Septoria ribis* and *Cercospora angulata*), spot disease of the cherry (*Cylindrosporium padi*), apple scab (*Fusicladium dendriticum*), strawberry leaf blight (*Sphærella fragariæ*), potato rot (*Phytophthora infestans*), and clover rust (*Uromyces trifolii*).

Apple rust.—Spraying with Bordeaux mixture and ammoniacal carbonate of copper on two trees did not prevent the appearance of the fungus in abundance.

Spot diseases of currants.—Bordeaux mixture and ammoniacal carbonate of copper sprayed on the Blue Naples and White Dutch currants, largely prevented injury from spot diseases.

Spot diseases of the cherry.—Ammoniacal carbonate of copper alone or following Bordeaux mixture was successfully used for this disease in several experiments.

Clover rust.—This disease was first observed in the rowen of red clover in August, 1890. "Later it was found quite abundant on the campus and college farm. So severely did it attack some of the plants, especially the stem and leaves, that in touching the plants the hands became covered with brown spores."

WEED PESTS, L. H. PAMMEL, B. AGR. (pp. 72–75).—Brief notes on ox-eye daisy (*Chrysanthemum Leucanthemum*), hawkweed (*Hieracium aurantiacum*), Canada thistle (*Cnicus arvensis*), horse nettle or sand briar (*Solanum carolinense*), spiny nightshade (*Solanum rostratum*), and dodder (*Cuscuta trifolii*) with a view to putting Iowa farmers on their guard against these pests.

PRELIMINARY REPORT ON THE EXAMINATION OF SOME SEEDS, P. H. ROLFS, B. S. (pp. 75–86, figs. 7).—An examination of the seeds of a number of species of clovers and grasses purchased by the station,

revealed the presence of sand, mixed grasses, and numerous weeds in considerable quantities.

NOTES ON METHODS OF CROSS-POLLINATION, F. A. SIRRINE (pp. 87–92).—Two methods of castrating the flowers of the plum were tried at the station in 1890, as follows:

"(1) Careful opening of the buds and picking out the stamens with a fine pair of tweezers. This was a very tedious way, but the petals helped to protect the tender style and stigma. (2) The cutting or tearing off of the whole calyx which bears the petals and stamens, leaving the ovary unprotected. This was done by taking the base of the bud between the prongs of the tweezers, simply holding the bud sufficiently close but not pinching it, then by giving the tweezers an upward jerk the part of the calyx which bears the stamens will be removed."

The same methods were used on the cherry, and the second method, with slight variations, on the apple and rose.

Successful crosses were obtained by using the pollen of Kentucky blue grass on the female plant of Texas blue grass. "In a white sport of red clover artificial pollination was tried with its own pollen, but seed was not produced." From planting corn in an isolated part of the field, removing the tassels, and hand-pollinating the ears without covering better results were obtained than from covering the corn with sacks. Before sunrise was found to be the best time for applying the pollen.

NOTES ON INSECTS, H. OSBORN, M. S., AND H. A. GOSSARD, B. S. (pp. 95–115, plate 1, figs. 10).—General statements regarding the injuries to meadows and pastures by insects, with suggestions as to means for their repression; notes on the tenderfoot leaf hopper (*Diedrocephala mollipes*), hurtful leaf hopper (*Deltacephalus inimicus*), *D. debilis*, destructive leaf hopper (*Cicadula exitiosa*), clover seed midge (*Cecidomyia leguminicola*), horn fly (*Hæmatobia serrata*), and apple maggot (*Trypeta pomonella*); and directions for spraying orchards. The four figures illustrating the notes on the first four insects named above are original.

BLOSSOMS OF ORCHARD FRUITS, J. L. BUDD, M. H. (pp. 115–118).—"The observations of the past 30 years on the prairies west of Lake Michigan sustain the proposition that the varieties of orchard fruits vary in hardiness of fruit buds and blossoms quite as much as they do in relative hardiness of tree. The proposition can also be sustained that the typical ironclad tree has hardier fruit buds and blossoms than the one that poorly withstands our trying changes of summer and winter." This is illustrated by references to a number of varieties of apples, cherries, plums, and pears. Attention is called to the fact that some of the Silesian and South Russian cherries have an additional provision for escaping untimely frosts in bearing two distinct sets of blossoms, one of which opens later than the other. In view of the accumulating evidence that fruit trees are not likely to be self-fertilized, the author advises the alternating of varieties in the rows of orchards, with special attention to differences in the time of blooming.

SOME OBSERVATIONS ON CONTAMINATED WATER SUPPLY FOR LIVE STOCK, M. STALKER, V. S. (pp. 118–120).—Observations by the author on sickness among farm animals caused by drinking impure water are cited to enforce the desirability of attention to this matter on the part of farmers.

Iowa Station, Bulletin No. 14, August, 1891 (pp. 73).

EFFECT OF FOOD UPON QUALITY OF MILK, J. WILSON, D. A. KENT, B. S., C. F. CURTISS, B. S. A., AND G. E. PATRICK, M. S. (pp. 123–142).—In this experiment as to the effect of rations containing different amounts of protein, fat, and carbohydrates on the composition of the milk, four cows were used, three being grade Shorthorns, and the other a grade Holstein, all of which had calved within from 14 to 44 days previous to the experiment. The difference in the relative amounts of nutrients was brought about by feeding corn-and-cob meal containing 3.24 per cent crude fat, 9.66 per cent crude protein, and 76.17 per cent carbohydrates (exclusive of cellulose) in the dry matter, *vs.* gluten meal containing 11.88 per cent fat, 21.58 per cent protein, and 56.08 per cent carbohydrates in the dry matter, the coarse fodder being the same in kind and amount at all times (12 pounds corn fodder and 4 pounds clover hay per animal daily). The experiment extended from March 22 to June 9, and included three 21-day periods, separated by transition periods of 10 days each.

Cows Nos. 21 and 22 each received daily in addition to the coarse fodder, 12¼ pounds of corn-and-cob meal in the first period, 10 pounds of gluten meal in the second period, and 13 pounds of corn-and-cob meal in the third period. The order was reversed in the case of cows 33 and 65, 10 pounds of gluten meal per animal being fed in the first and third periods, and 12¼ pounds of corn-and-cob meal in the second period. The uneaten coarse fodder was weighed back, but all except the corn fodder, a small quantity of which was left, was eaten clean, without regard to the kind of grain fed. The milk of each cow was sampled every morning and evening, the samples being preserved for from 4 to 7 days and the solids determined in the composite samples at the end of that time by a gravimetric method, and the fat by the Babcock centrifugal method. The analyses of the milk, therefore, represent the average composition of the milk of each milking during the entire period instead of the composition on any particular day.

The analyses of the corn-and-cob meal, the gluten meal, and the milk, and statements as to the total amounts of food consumed, the total yield of milk, of solids, and of butter fat, and the pounds of fat per 1,000 pounds of solids-not-fat, are tabulated for each animal in each period. From these data the total amounts of nutrients in the grain rations consumed during each period (the only variable food) have been calculated for each animal, and these, together with the total yields of milk and of fat during each period and the average composition of the milk, are given in the following table:

Record of each animal per period.

Period.	Grain ration of cows Nos. 21 and 22.	In grain. Crude fat.	In grain. Crude protein.	In grain. Carbohydrates.*	Milk produced. Cow No. 21. Yield of milk.	Cow No. 21. Total solids.	Cow No. 21. Fat.	Cow No. 21. Solids-not-fat.	Cow No. 21. Amount of fat.	Cow No. 22. Yield of milk.	Cow No. 22. Total solids.	Cow No. 22. Fat.	Cow No. 22. Solids-not-fat.	Cow No. 22. Amount of fat.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*	*Pounds.*
1	Corn and cob meal	7.23	21.53	169.76	631.25	11.57	3.43	8.14	21.67	604.75	11.95	3.57	8.38	21.56
2	Gluten meal	23.44	42.57	110.59	641.50	12.53	4.04	8.49	25.93	582.00	12.37	3.91	8.46	22.74
3	Corn and cob meal	7.67	22.85	180.15	559.00	11.86	3.22	8.64	17.97	527.00	12.05	3.37	8.68	17.78

Period.	Grain ration of cows Nos. 33 and 65.	In grain. Crude fat.	In grain. Crude protein.	In grain. Carbohydrates.	Milk produced. Cow No. 33. Yield of milk.	Cow No. 33. Total solids.	Cow No. 33. Fat.	Cow No. 33. Solids-not-fat.	Cow No. 33. Amount of fat.	Cow No. 65. Yield of milk.	Cow No. 65. Total solids.	Cow No. 65. Fat.	Cow No. 65. Solids-not-fat.	Cow No. 65. Amount of fat.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*	*Pounds.*
1	Gluten meal	23.44	42.57	110.59	753.5	12.43	3.97	8.46	29.94	487.5	13.27	4.15	9.12	20.25
2	Corn and cob meal	7.23	21.53	169.76	601.5	11.45	3.15	8.30	18.97	379.0	12.69	3.51	9.18	13.30
3	Gluten meal	23.44	42.57	110.59	560.5	12.46	3.85	8.31	21.58	374.5	13.01	3.72	9.20	13.95

*Exclusive of cellulose.

The foregoing table shows that when the gluten meal, containing larger amounts of protein and fat, was fed there was an increase both in the percentage of total solids and fat and in the total amount of fat produced during the period in the case of every cow. While there were slight changes in the percentage of solids-not-fat, these changes seemed to be independent of the food, for in the case of every cow except No. 33 there was a steady increase in the percentage of solids-not-fat from the beginning to the close of the experiment regardless of the changes made in the grain food. The proportion of the fat to the solids-not-fat was noticeably larger with gluten meal. This would seem to be a case of a one-sided increase of the fat, such as has been previously noticed in a few isolated cases only. The increase in the percentage of fat when the cows were changed from the corn-and-cob meal to the gluten meal amounted in some instances to 0.61 and 0.70 per cent; and when they were changed from gluten meal to corn-and-cob meal there was a decrease of from 0.54 to 0.82 per cent in the fat. The interest of the subject renders additional data for a larger number of animals very desirable.

Calf-feeding experiment, J. Wilson, C. F. Curtiss, B. S. A., D. A. Kent, B. S., and G. E. Patrick, M. S. (pp. 143–151).—A comparison of whole milk and skim milk for young calves. Four calves, two Shorthorns and two Holsteins, a bull and a heifer of each, were used for the trial. They varied in age from 33 to 64 days, and were fed from April 1 to June 30—91 days. Each day the milk from three cows was divided into two equal parts, one half being divided equally between the two bulls, and the other half set for 12 hours and then skimmed, and the skim milk fed to the two heifers. An attempt was made to make the skim-milk ration approximately equal to the whole-milk ration by adding 1.5 pounds of ground flaxseed per day to the skim milk of each animal. All of the calves received grain (a mixture of equal parts of ground oats, ground barley, corn meal, and wheat bran) and clover hay in addition to the milk. The amount of these was the same for each calf, and was increased with the growth. The rations fed and gains made during periods of 15 days, together with a summary for the 91 days' feeding, are tabulated. During the whole experiment the gains on the whole-milk ration were, Shorthorn 178 pounds and Holstein 234 pounds; and on the skim-milk ration, Shorthorn 155 pounds and Holstein 171 pounds.

The best results as to gain came from the whole milk, but taking all things into consideration we regard the outcome of the experiment as quite favorable to the skim milk and flaxseed ration. If the calves were to be judged by their condition as to thrift and general appearance, omitting the test of the scales, the verdict would be in favor of the skim milk and flaxseed. * * * Heredity may or may not have figured in the results, but if it did it was against the skim-milk ration. Both skim-milk calves were in better condition than either of the others. At the end of the experiment the milk was taken away from all of the calves and they were put on pasture and equal grain rations. Here again the results were in favor of the skim-milk calves. * * *

The cost of producing a pound of gain (estimating new milk at 87½ cents per 100 pounds, skim milk at 15 cents per 100 pounds, grain at 1 cent per pound, hay at $5 per ton, and flaxseed meal at 3½ cents per pound) was 7.6 cents for the fresh-milk ration and 5 cents for the skim-milk ration.

A FEEDING EXPERIMENT FOR MILK, J. WILSON, C. F. CURTISS, B. S. A., D. A. KENT, B. S., G. E. PATRICK, M. S., AND E. N. EATON, B. S. (pp. 152–161).—This is a record of a single cow from February 25 to June 18. In the first 2½ months of this time corn fodder, corn silage, sorghum silage, and roots were compared, feeding 20 pounds of corn-and-cob meal per day with each coarse fodder; from May 19 to June 7 half the corn-and-cob meal was replaced by 7 pounds of bran and 3 pounds of linseed meal, and fed with hay; and from June 9 to 18 this grain ration was reduced one half and fed with pasturage. The data showing the amounts of food consumed and of milk yielded, and the composition of the milk are tabulated. "The substitution of bran and oil meal for half the amount of corn meal resulted in a marked increase in both quantity and quality of milk, the increase in quality being still more than the increase in quantity."

PIG-FEEDING EXPERIMENT, J. WILSON, C. F. CURTISS, B. S. A., D. A. KENT, B. S., AND G. E. PATRICK, M. S. (pp. 162–165).—This is a record of the food consumed and the live weight gained by a sow and her litter of seven pigs for 153 days. The principal food was ear corn and shelled corn, supplemented at different times by ground barley, linseed meal, corn-and-cob meal, and bran, all of which were soaked before feeding. The sow and pigs together gained 626¾ pounds live weight, and consumed 2,032 pounds of grain during the trial. The cost of the rations is not given.

REPORTS ON ENTOMOLOGICAL WORK, H. OSBORN, M. S., AND H. A. GOSSARD, B. S. (pp. 166–180, fig. 1).—The following summary of this article is taken from the bulletin:

The clover seed caterpillar (*Grapholitha interstinctana*), which has been abundant and destructive, is described and figured in different stages, and the conclusion reached [from observations cited] that cutting the clover and storing it while the caterpillars are still in the clover heads, results in the entire destruction of the insect.

Experiments with hopper-dozers for grass leaf hoppers show that this method can be used very successfully in capturing the insects [especially while immature]; that the simplest form (a flat sheet of sheet iron) was most satisfactory; that one application resulted in adding 31 per cent to the crop of hay on a plat experimented on, and in one experiment leaf hoppers were captured at the rate of 376,000 per acre.

Kerosene emulsion for plant lice was used once with poor success, but later an application of a good emulsion by thorough methods resulted in complete success.

Grasshoppers are mentioned as troublesome this season and the reports of Rocky Mountain grasshoppers (*Caloptenus spretus*) referred to. No present damage to Iowa is apprehended from this latter species, and methods of controlling the common native species when numerous are discussed.

The flavescent clover weevil [*Sitones flavescens*] is found abundant at Ames. Its distribution is referred to and its method of work described. Information regarding its occurrence in other parts of the State is requested.

The wheat bulb worm [*Meromyza americana*] has occurred in moderate numbers, but abundant parasites [*Coelinius meromyzæ*, and two undetermined species] have been found to attack it at Ames, and its serious multiplication is not considered probable.

Directions for making kerosene emulsion and arsenical solutions are briefly given.

BREEDING OF ORCHARD AND GARDEN FRUITS, J. L. BUDD, M. H. (pp. 181–190).—The experience of the author and other fruit growers in Iowa and other States of the Northwest is cited in support of the following propositions:

(1) In the States west of Lake Michigan no important advances have been made in the great work of adapting fruits to our peculiar climate and soil by growing seedlings from the varieties introduced from southwest Europe, nor from their seedlings originating in the Eastern or Southern States.

(2) Our valuable seedlings of the orchard and garden fruits have come from the varieties introduced from east Europe or north Asia and from our native species.

(3) Methodic crossing and hybridizing have given in the past and promise to give in the near future more valuable and certain results than we can hope for from chance breeding from intermingled varieties and species.

Brief notes are given on the following crosses of apples made at the station during the past 4 years: *Crosses made 4 years ago.*—Silken Leaf with pollen of Osceola, Roman Stem, and Longfield; Department Cross with Osceola and Scott Winter. *Crosses made 3 years ago.*—Beautiful Sweet with Garden Apple, Ostrokoff with Ben Davis, Department Cross with Ben Davis, Antonovka with Wythe, Little Hat with Roman Stem, Anisovka with Autumn Strawberry, Pyrus Toringo with Wythe, Pyrus Ringo with Duchess. *Crosses made 2 years ago.*—Duchess with Iowa Keeper, Rawles Janet, Roman Stem, Tallman Sweet, Ben Davis, and Boone Crab; Iowa Keeper with Wythe; Wythe with Grimes Golden, Roman Stem with Wythe. The seedlings from the last three crosses are not at all promising.

AN APHTHOUS AFFECTION AMONG DAIRY COWS OF THE STATE, M. STALKER, V. S. (pp. 191–195).—A brief account of observations on a disease which has recently appeared among cattle, especially milch cows, in southeastern Iowa. The symptoms are stated and suggestions made regarding treatment. The disease seems to differ in some respects from the forms of aphtha previously described. The cause has not yet been investigated.

Kansas Station, Bulletin No. 20, July, 1891 (pp. 46).

EXPERIMENTS WITH WHEAT, C. C. GEORGESON, M. S., H. M. COTTRELL, M. S., and W. SHELTON (pp. 1–46).—These include experiments on (1) methods of seeding, (2) effects of character of seed, (3) effect of top-dressing with plaster and of spring harrowing, (4) single varieties *vs.* a mixture of varieties for seed, (5) effects of pasturing wheat, (6) continuous cropping with wheat, (7) rotation experiments, and (8) test of varieties. Accounts of previous experiments with wheat may

be found in Bulletins Nos. 7 and 11 of the station (see Experiment Station Record, vol. I, p. 214, and vol. II, p. 219).

In the first-named five lines of these experiments the plats were one-twentieth acre in extent, measuring 33 by 66 feet; with but few exceptions not less than five plats were subjected to the same treatment, and the conclusions are based on the average yield of the five. Plats thus similarly treated are not placed by the side of each other, but, as far as the formation of the land will permit, they are placed alongside of and in alternation with the plats with whose treatment or non-treatment they are to be compared. A space of 2 feet in width separates them along the sides, and at the ends a turning row of 12 feet in width separates adjoining series.

The land was believed to be quite even in fertility.

Methods of seeding (pp. 3–6).—The methods of seeding tested were (1) broadcasting, (2) by shoe drill with press wheels, (3) by shoe drill without press wheels, (4) by hoe drill, (5) by roller drill, (6) listing, and (7) cross-drilling, each of the methods being tried on five different plats. The land was a clay loam and had been used for oats in 1890. Five pecks of Zimmerman seed per acre were sown on all except the listed plats, where from 3 to 4 pecks per acre were used. The results are tabulated for each method, and a summary is given of all the trials. "Broadcasting gave the best yield of all, followed closely by the plats seeded with the roller drill. The broadcasted plats had a good stand, though not so even as the stand on the drilled plats. It is worthy of note that these same two methods of seeding, viz, the roller drill and broadcasting, gave also the best results in last year's oats experiments." The results where the shoe drill and the hoe drill were used were "practically identical." There was no perceptible advantage from cross-drilling. The lowest yield occurred where the wheat was listed. This is believed to be largely attributable to the large amount of rain.

Effects of character of seed (pp. 7–9).—The effects were studied on 18 plats of using "common," "light," "heavy," and selected seed, and seed from wheat cut while in the milk.

The common seed was the wheat as it came from the thresher—simply cleaned from chaff and straw. It weighed 63 pounds per struck bushel. The light seed was taken from the screenings obtained by running the common seed through the fanning mill, and consisted chiefly of small with some shriveled and cracked seed. It weighed 58½ pounds to the struck bushel. The heavy seed consisted of the best grade that could be gotten by running the common seed through the fanning mill. It weighed 64½ pounds to the struck bushel.

[The yield per acre and the weight of the wheat per bushel are tabulated for each kind of seed.] Taking the common seed as the standard, which may fairly represent the character of the seed usually sown by our farmers, this experiment shows a gain in the yield by the use of better seed, whether obtained by grading it with a fanning mill or by selecting choice heads and taking the seed from them. On the contrary, a loss is entailed by the use of seed cut too early, or light and inferior seed.

Effects of top-dressing wheat with plaster and of spring harrowing (pp. 9, 10).—Brief tabulated notes on the results of applying 400 pounds of plaster per acre to wheat, and of harrowing wheat in the spring (April 12) when the plants were 8 to 10 inches high. The plaster showed "no

marked effect on the yield;" and the spring harrowing "was in this case a decided disadvantage to the crop."

Single vs. a mixture of varieties for seed (pp. 10,11).—On seven plats Zimmerman, Buckeye, and Red May varieties were sown alone and in mixtures of twos and of all three. The tabulated results show that in each case the yield where two varieties were mixed was larger than the average yield of the same two varieties when used alone. Thus when Zimmerman and Buckeye were sown singly the average yield was 38.41 bushels, but when a mixture of the two was used the yield was 43 bushels per acre, etc. The lowest yield (39.33 bushels) was where a mixture of the three varieties was sown, being lower than the average of these three varieties when sown singly.

Effects of pasturing wheat (pp. 11, 12).—Trials of wheat sown September 15, on fifteen plats, on five of which cows were pastured in October and November, and on five others in April, showed an average gain of 1.5 bushels of wheat per acre on the five plats not pastured over those pastured. "Whether the food obtained by pasturing will equal the value represented by this difference in yield, can not be determined on so small a scale. This pasturing of wheat is an important practical question. Many farmers place no small dependence on the food that their wheat fields furnish in fall and spring, and cattle will occasionally even run on the wheat all winter." It is suggested that a wet clay soil would be more liable to injury from this practice than a dry one.

Continuous cropping with wheat (pp. 12, 13).—The yields of wheat on an acre of medium heavy loam land without manure of any kind, are tabulated for each year since 1880, when the experiment was commenced. Excluding 2 years when the crop was winter-killed, the average yield per year has been 29.27 bushels. The yield in 1891 was 30.75 bushels.

Rotation experiments (pp. 13–19).—The plan is given at considerable length of two series of experiments in rotation, "with wheat as the basis, with a view to ascertain what system of cropping will yield the best returns." The yield of wheat for 1891 is tabulated. As this is the first year's crop of one series and the second of the other, no special interest attaches to the results as yet.

Test of varieties (pp. 19–46).—Data are given for 240 varieties of wheat tested at the station during the past year. Arrangements have been made by which photographs of the heads of the varieties tested will be furnished to all who may desire them, at a cost of $2.50 for the entire set.

Kansas Station, Bulletin No. 21, August, 1891 (pp. 28).

SECOND REPORT ON FUNGICIDES FOR STINKING SMUT OF WHEAT, W. A. KELLERMAN, PH. D. (pp. 47–72, plate 1).—An account of experiments with fungicides for stinking smut of wheat (*Tilletia fœtens* and

T. tritici) in continuation of those reported in Bulletin No. 12 of the station (see Experiment Station Record, vol. II, p. 220). Reference is also made to experiments on oat smut, reported in Bulletins Nos. 8 and 15 and the Annual Report of the station for 1889 (see Experiment Station Record, vol. I, p. 216, and vol. II, pp. 340 and 638). The bulletin is illustrated with a plate showing smutted and sound heads of wheat. The land used for the experiments reported in this bulletin was upland soil used the previous season in experiments on oat smut.

The seed used was artificially smutted. It was placed in a box and a large quantity of more or less broken smutted grain added, and the whole was thoroughly stirred with hoe and shovel till the grains were black with smut. Without further preparation this was used for the alternate untreated plats. * * * The variation in amount of smut on these plats was enormous, and the reason for it is not fully known; yet the fact that all the untreated plats were planted with the drill successively may account for at least some of the variation, since the smutted grains are of much less specific gravity than the sound ones, and would be sown in greater abundance the nearer the seed box was empty.

Different methods for treating the smut were tried on 93 plats, each containing 0.04 of an acre; the alternate plats remained untreated. Bordeaux mixture, eau celeste, copper sulphate, copper acetate, copper nitrate, copper chloride, mercuric chloride, potassium bichromate, and "Ward's Seed Manure" were used in different forms and applied, with one exception, during 24 hours. Hot water at temperatures varying from 138° to 127° F. was also used, the seed being dipped from 5 to 15 minutes, and cooled in water at ordinary summer temperature, in an ice-salt mixture or in 10 per cent $CuSO_4$ solution. The results as indiindicated by the yields of smutted and sound grain on both the treated and untreated plats, are stated in a table, and those on a number of plats are illustrated by diagrams. The following treatments destroyed all the smut and gave a yield of grain greater than the average of the two adjacent untreated plats: Copper sulphate 0.5, or 1 per cent solution, 24 hours, or 0.5 per cent solution 12 hours, limed; copper acetate 0.5 per cent solution, 24 hours; copper nitrate 0.5 per cent solution, 24 hours; hot water 137°, 136°, or 131° F., 5 minutes, cooled in water of ordinary summer temperature; 136°, 135°, or 128° F., 10 minutes, cooled; 129° F., 15 minutes, cooled; 130°, 129°, 128°, or 127° F., 10 minutes, cooled in 10 per cent solution $CuSO_4$. In a considerable number of cases the yield on the treated plats was much greater than would be expected by merely replacing the smutted heads by sound ones. Whether this extra increase is due to an increase in the percentage of seeds germinating or to an increased vigor of the plants from the treated seed, has not been determined.

In general the results of the experiments reported in this bulletin confirm the conclusions drawn from previous experiments.

The stinking smut of wheat is effectually prevented by treating the seed with water at a temperature of 131° F., 15 minutes. For cheapness as well as for greater efficiency (without injury to seed), this is recommended over all other

fungicides. Not only is the yield increased by an amount equal to the portion destroyed by smut, but in nearly all cases there is an extra increase, usually much beyond this amount.

Kentucky Station, Bulletin No. 34, August, 1891 (pp. 23).

COMMERCIAL FERTILIZERS, M. A. SCOVELL, M. S.—A popular discussion on fertilizers and their use; analyses of 67 samples of commercial fertilizers, including bone, offered for sale in the State during 1891; and the schedule of trade values of fertilizing ingredients.

Kentucky Station, Bulletin No. 35, September, 1891 (pp. 16).

EXPERIMENTS WITH WHEAT, M. A. SCOVELL, M. S., AND C. L. CURTIS (pp. 3–14).—This is a report of the third year of experiments with wheat, the same soil (a blue grass soil) being used as in the previous experiments. The experiments of previous years were reported in Bulletins Nos. 21 and 30 of the station (see Experiment Station Record, vol. I, p. 218, and vol. II, p. 227). The season was on the whole a favorable one for wheat.

Test of varieties (pp. 4–10).—Tabulated data are given for 31 varieties of wheat, 21 of which yielded over 25 bushels of wheat per acre. The weight of wheat per bushel ranged from 57 to 63 pounds with the different varieties. Egyptian (33.5 bushels) and Canadian Finley (32.25 bushels) gave the largest yields. The station offers to distribute, in small quantities, seed of any of the varieties tested. Several of the varieties have been tested for the past 3 years. The tabulated yields of these varieties show that "the Egyptian wheat has made the highest average yield for 3 years; then come Hunter White and German Emperor."

Different methods of seeding (pp. 10, 11).—A tabular statement is given of the results of a comparison of drilling and broadcasting wheat, in each case at the rate of from 0.5 to 2 bushels of seed per acre; and also of drilling 5.5 pecks of seed per acre at depths of 1, 2, 3, and 4 inches. The latter tests were inconclusive. Where from 0.5 to 1.25 bushels of seed were used per acre the results "were very much in favor of the drilling;" but with 1.5 and 2 bushels of seed the yields were better with broadcasting than with drilling.

Test of fertilizers (pp. 11–14).—A continuation of the experiment with fertilizers for wheat, using the same kinds and amounts as in the 2 previous years. "The results are the same as they have been for the last two seasons—that fertilizers, whether used in combination or singly, have no effect upon the yield of wheat. On the same lands, for corn, potatoes, hemp, and tobacco the results of potash fertilizers show very favorably."

EXPERIMENTS WITH OATS, M. A. SCOVELL, M. S., AND C. L. CURTIS (pp. 14–16).—Tabulated notes on 22 varieties of oats. "But one variety

yielded above 40 bushels, viz. Golden Giant Side. * * * Several other varieties yielded well, the best being Barley [38 bushels], Welch [37.25 bushels], and Early Dakota [35 bushels]." A comparison of the yields of 15 varieties, which have been tested for 3 successive years, shows that "the Barley oats and Early Dakota oats have made the best average, both of which we consider good standard varieties."

Massachusetts Hatch Station, Meteorological Bulletins Nos. 32 and 33, August and September, 1891 (pp. 4 each).

A daily and monthly summary of observations for August and September at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

Minnesota Station, Bulletin No. 16, April, 1891 (pp. 12).

THE COMMON SCAB OF SHEEP, O. LUGGER, PH. D. (pp. 75–84, figs. 7).—Popular descriptions of scab mites, especially that causing the common scab of sheep (*Psoroptes communis*, var. *ovis*), directions for treatment, and formulas for a number of sheep dips. Special reference is made to the publication of this Department entitled Animal Parasites of Sheep (see Experiment Station Record, vol. II, p. 79), from which six of the figures illustrating the bulletin are taken.

Minnesota Station, Bulletin No. 17, August, 1891 (pp. 24).

MIGRATORY LOCUSTS IN MINNESOTA IN 1891, O. LUGGER, PH. D. (pp. 87–108, figs. 15).—Accounts of observations and experiments by the author in the Red River Valley, illustrated descriptions of the Rocky Mountain locust (*Coloptenus spretus*), lesser migratory locust (*Melanoplus atlantis*), and pellucid locust (*Camnula pellucida*), and suggestions as to remedies. Statements regarding the ovipositing of the Rocky Mountain locust and the legislation needed in Minnesota against locusts are quoted from Bulletin No. 8 of the station (see Experiment Station Record, vol. I, p. 230). The observations of 1891 agreed with those made in previous years in showing that the plowing of land after the eggs have been deposited is an effective means of repression. Hopper-dozers were used with good results. The following species of insects were observed to prey upon the locusts: Red mite (*Trombidium locustarum*), blister beetle (*Epicauta pennsylvanica*), ground beetle (*Calosoma calidum*), *Pasimachus* sp., and wolf spider (*Phydippus tripunctatus*). Previous reports on invasions of locusts in Minnesota may be found in Bulletin No. 8 (see Experiment Station Record, vol. I, p. 230) and the Annual Report of the station for 1888 (see Experiment Station Bulletin No. 2, part II, p. 92).

Minnesota Station, Bulletin No. 18, September, 1891 (pp. 24).

NOTES ON STRAWBERRIES AND RASPBERRIES, 1891, S. B. GREEN, B. S. (pp. 111–121).—*Strawberries.*—Tabulated and descriptive notes on 30 varieties. The leading varieties in yield and quality were Warfield No. 2, Michel Early, Haverland, Bubach No. 5, Park Beauty, Crawford, Shuster Gem, Jessie, Wilson, and Crescent.

The Warfield No. 2 strawberry fertilized with Michel Early gave the largest yield of any variety grown. It yielded something over 90 boxes of berries from one row 160 feet long. This is at the rate of about 7,000 boxes per acre. * * *

[The strawberries tested] were cultivated on the matted-row system and were heavily mulched with straw as soon as the ground was frozen. This mulch was left on to retard the plants until the new growth commenced to look a little yellow. It was then drawn away into the rows from directly over the plants to allow them to push through. This method we have found very satisfactory.

Raspberries.—Descriptive notes on 11 red and 5 cap varieties. "Among the reds I would recommend Marlborough, Hansell, and Cuthbert, and among the black caps, Ohio and Nemaha. Other varieties that should be in every garden, on account of their productiveness and sure bearing qualities, are Schaeffer Colossal and Caroline."

EVERGREENS FROM SEED, S. B. GREEN, B. S. (pp. 121–126).—Brief accounts are given of experiments in raising white pine (*Pinus strobus*), Scotch pine (*P. sylvestris*), white spruce (*Picea alba*), and European larch (*Larix europæa*). The seed was sown in the latter part of April.

The Scotch pine seed started very strongly in 2 weeks. The white pine seed did not start until 2 weeks after the Scotch, but the plants then grew with so much vigor that these seedlings were in a short time as large as those of the Scotch pine. Only a few of the white spruce seeds germinated, and they made a very slow growth. * * * The larch seed was damaged and only a small per cent of it grew.

The following suggestions are made from these experiments:

(1) By following a few simple directions it is a very easy matter to grow evergreens from seeds.

(2) Evergreen seeds germinate readily and the greatest danger comes when the plants are young and growing fast. They are then likely to die if the weather is warm and moist.

(3) The damping-off of evergreens in the seed bed may be greatly reduced, if not entirely prevented, by covering the seed bed with sand or other mulch.

(4) Moist land is not safe to use for a seed bed, and the best seed bed is a rather dry, sandy leaf mold.

(5) Young evergreen seedlings need protection from the sun in very bright or long-continued sunny weather, both in summer and winter. This should be so arranged that the beds may be shaded at pleasure. After ordinary rains the shades should be taken off and need not be put on again until the bed is well dried off.

(6) There is much more danger to coniferous seedlings from warm moist weather than from long-continued drouth, but we can guard against danger from either by exercising a little care.

(7) So very many seedlings may be grown in a small bed that I think it will pay nurserymen and foresters to raise their own seedlings, although they grow very slowly the first few years.

(8) Probably 1 inch is about the right depth at which to sow the seed of hardy evergreens having large seeds, such as the pines and the Norway spruce.

Notes on native fruits, S. B. Green, B. S. (pp. 126–130, fig. 1).—Brief descriptive notes on the sand cherry (*Prunus pumila*) and the buffalo berry (*Shepherdia argentea*), with accounts of experiments at the station. The author believes these species capable of great improvement.

Summer propagation of hardy plants, S. B. Green, B. S. (pp. 130–132).—A brief account of an experiment in propagating hydrangea, spiræa, barberry, Tartarian honeysuckle, and 11 varieties of roses. To keep the young plants from wilting in the comparatively dry climate of Minnesota, pieces of burlap were stretched over the beds.

This was not laid horizontally, but was inclined to the south, so that the northern edge was at least 1 foot above the bench, while the southern edge rested directly on the bench. By putting this shade on about 9 o'clock and leaving it on until about 5 we could keep the cuttings from wilting in the driest weather. It was also found that if the burlap was syringed with water it had much greater cooling effect, and that comparatively little attention was necessary in watering.

New Mexico Station, Bulletin No. 3, June, 1891 (pp. 19).

A preliminary account of some insects injurious to fruits, C. H. T. Townsend (figs. 8).—Compiled notes on the following insects observed in New Mexico in 1891, with brief accounts of observations by the author and suggestions as to remedies: Vine leaf hopper (*Typhlocyba vitis*), codling moth (*Carpocapsa pomonella*), woolly louse of the apple (*Schizoneura lanigera*), oyster-shell bark louse (*Mytilaspis pomorum*), scurfy bark louse (*Chionaspis furfurus*), apple tree tent caterpillar (*Clisiocampa americana*), peach tree borer (*Sannina exitiosa*), peach aphis (*Myzus persicæ*), green June beetle (*Allorhina nitida*), plum aphis (*Aphis prunifolii*), twelve spotted diabrotica (*Diabrotica 12-punctata*).

New York Cornell Station, Bulletin No. 29, July, 1891 (pp. 20).

Cream raising by dilution, H. H. Wing, B. Agr. (pp. 65–71).—This is a report of a second series of experiments concerning the effects of diluting milk on the completeness of the creaming by setting. The first series, published in Bulletin No. 20 of the station (see Experiment Station Record, vol. II, p. 284), indicated that "instead of aiding the creaming, the addition of water, either warm or cold, was a positive detriment to the thorough separation of the cream."

In the experiments here reported trials were made with the mixed milk of the herd, and with the mixed milk of the five cows furthest advanced in the milking period, the milk being in both cases diluted with one half its volume of water at from 98° to 134° F., and set in cans in a Cooley creamer at about 40° F. Comparisons were made in each case with undiluted milk set under conditions otherwise the same. In all the trials the percentage of fat remaining in the skim milk was larger where the milk had been diluted. The milk of the five cows

somewhat advanced in the milking period creamed very imperfectly, only a little more than one half of the fat of the milk rising in the cream. When the milk of these five cows was heated to 135° F. before setting, part being subsequently diluted one half with water at 135° F. and part set undiluted, the creaming was more satisfactory in both cases, but the skim milk still retained 1.32 to 1.82 per cent of fat, and there was no advantage from diluting. The milk of three of these cows was then mixed with an equal amount of the milk from the herd and it was found that this mixture creamed nearly as completely as the herd milk set alone, the skim milk averaging only 0.49 per cent of fat. "In other words, while dilution with water did not in the least aid in the creaming of this obstinate milk, dilution with the milk of other cows made it cream almost as readily as did the milk of the other cows."

Reference is made to experiments on this subject at the Vermont Station (Newspaper Bulletin No. 3), which "showed a marked advantage from diluting the milk with warm water" when the milk was set at 58° F.; and at the Illinois Station, as reported in Bulletin No. 12 of the station (see Experiment Station Record, vol. II, p. 404), in which there seemed to be an advantage from diluting Holstein milk but a disadvantage from diluting Jersey milk, although "in every case the addition of water caused the cream to rise more quickly than when water was not added."

The author summarizes the work done on this subject at the New York Cornell Station and concludes that "in all of the trials we have made in diluting milk we have never received any advantage whatever from the water added; in fact in all the cases but one the addition of water, either hot or cold, has been a distinct disadvantage."

Effects of a delay in setting upon the efficiency of creaming, H. H. Wing, B. Agr. (pp. 71–76).—To study the effects of delay in setting milk on the thoroughness of the creaming and churning, fourteen trials were made in which the creaming of milk set immediately after milking was compared with that of milk which was not set for from 45 minutes to 3½ hours after milking and which in the mean time was either kept warm (82°–95° F.) or allowed to cool; and seven churning tests were made of cream from milk which had received the different treatments. The milk was in all cases stirred up just before setting and was set in Cooley cans in ice water. The data obtained in each of these trials are given in four tables, and similar experiments at the Maine Station reported in the Annual Report of the Station for 1890, part II (see Experiment Station Record, vol. III, p. 22) are cited. "It would seem that the conclusion from all these experiments must be that there is very slight danger of loss of fat in delaying the setting of milk for a considerable time after it is drawn, particularly if the temperature of the milk does not fall much below 80° F."

COMPARISON OF THE BABCOCK CENTRIFUGAL METHOD WITH THE GRAVIMETRIC METHOD OF MILK ANALYSIS, H. SNYDER, B. S. (pp. 77–80).—Data are given on the comparison of the percentages of fat indicated by the Babcock centrifugal method and the gravimetric (asbestus) method in 37 samples of whole milk, 48 of skim milk, 6 of buttermilk, and 5 of butter, duplicate tests being made in many instances.

Of 55 determinations of the fat in whole milk by the Babcock method, the results of 23 differed from those of the gravimetric method by 0.1 per cent or over, while only 7 differed by 0.15 per cent or over, the largest difference being 0.26 per cent. Sixteen of the 77 determinations by the Babcock method in skim milk differed from the gravimetric results by 0.1 per cent or over, the largest difference recorded being 0.2 per cent. Three of the 10 determinations in buttermilk differed by from 0.1 to 0.18 per cent from the gravimetric, and 4 out of the 5 determinations in butter differed from the gravimetric by from 0.28 to 0.7 per cent.

RELATION OF FIBRIN TO THE EFFECTUAL CREAMING OF MILK, H. SNYDER, B. S. (pp. 81, 82).—The results are given of numerous determinations of the fibrin in the milk of several cows, made to ascertain whether a relation exists between the facility of the creaming and the content of fibrin. Measuring the fibrin present by the volume of oxygen liberated when milk was shaken with hydrogen peroxide "it appears that there is no definite relation between the amount of fat in the skim milk [thoroughness of the creaming] and the volume of oxygen liberated. The fat in the skim milk is the measure of the efficiency of the creaming process, and the volume of oxygen liberated is supposed to be proportional to the amount of fibrin present; but the highest percentage of fat in the skim milk is accompanied by as low a volume of oxygen as is the lowest per cent. It is evident that there are other factors of equal if not of more importance than fibrin that affected the creaming process of these samples."

New York Cornell Station, Bulletin No. 30, August, 1891 (pp. 40).

SOME PRELIMINARY STUDIES OF THE INFLUENCE OF THE ELECTRIC ARC LIGHT UPON GREENHOUSE PLANTS, L. H. BAILEY, M. S. (pp. 85–122, plates 2, figs. 7).—A record of experiments by the author in the winter and spring of 1890 and 1891 in a low, flat-roofed forcing house (20 by 60 feet), designed for the growing of lettuce, radishes, and cuttings.

The house is ventilated entirely from the peak by small windows hinged at the ridge. It is heated by steam, the riser running overhead and the returns all lying under the benches. This house was divided by a tight board partition into two nearly equal portions for our purpose. One compartment was treated to ordinary conditions—sunlight by day and darkness by night—and the other had sunlight during the day and electric light during a part or whole of the night. In all

the experiments the lamp was suspended from the peak of the house, the arc being $2\frac{1}{2}$ feet above the soil of the bench over which it was placed. * * *

During the first winter (January to April, 1890) we used a 10 ampere, 45 volt. Brush arc lamp of 2,000 nominal candle power. This was run all night—from dusk until daylight—from January 23 to April 12. At first the light was started at 4:30 in the afternoon and ran until 7:30 in the morning, but as the season advanced the run was shortened, until in April it ran from 7 o'clock till 5. For the first 6 weeks the light was naked, but during the remainder of the time an ordinary white opal globe was used.

The experiments were in three series, (1) with a naked light running all night, (2) with a light protected with a white opal globe and running all night, (3) with a naked light running a part of the night.

Experiments with a naked light running all night.—These were with radishes, carrots, endive, spinach, cress, lettuce, and peas.

"The general effect of the light was to greatly hasten maturity, and the nearer the plants grew to the light the greater was the acceleration. This tendency was particularly marked in the leaf plants—endive, spinach, cress, and lettuce. The plants 'ran to seed' before edible leaves were formed, and near the light the leaves were small and curled."

Details are given in notes and tables, and the results are illustrated with cuts of specimen plants from both the light and dark houses. In the case of lettuce it was observed that the plants did not increase in size uniformly with the increase in distance from the lamp. The lower and higher plants alternated somewhat regularly, although there was a general progression in height. "This alternating elevation and depression is perhaps due to the concentric bands of varying intensity of light which fall from the arc and which are caused by the uneven burning of the carbons."

In the case of endive "it chanced that for a time two rows grew parallel to each other in the light house, but one stood in full light while the other was shaded by an iron post 1.5 inches in diameter." At the end of 2 months the plants in the row exposed to the full light averaged 49.6 grains in weight, while those in the shaded row averaged 93.8 grains.

In the dark house an average plant of the same age weighed 575 grains, and it was larger leaved and darker colored than those grown in the other compartment. * * *

The young radish plants [on the highest bench] were strongly attracted by the light, and in the morning they all leaned at an angle of from 60° to 45° towards the lamp. During the day they would straighten up, only to reach for the lamp again on the succeeding night. This was repeated until the roots began to swell and the plant became stiff. As the plants grew, the foliage became much curled, and the amount of this injury was in direct proportion to the nearness to the lamp. Those nearest the lamp (within 3 to 6 feet) were nearly dead at the expiration of 6 weeks, while those 14 feet away showed little injury to the leaves.

The following figures represent the average weight in ounces of radishes in the light and dark houses respectively: Entire plant, 0.18 and

0.31; top, 0.08 and 0.14; tubers, 0.07 and 0.16. The percentages of marketable tubers were 27 and 78.

The table shows that the crops obtained in the dark or normal house were about twice as large as those in the light compartment. The entire plants and the tops were almost half lighter in the light house, and the tubers were more than half lighter, while the per cent of tubers large enough for market was as 9 in the light house to 26 in the dark house. And it should also be said that the average size of the tubers graded as marketable was less in the light house than in the other. * * *

A chemical analysis of samples of radishes from the light house (in both full light and shadow) and the dark house gave the following results:

Samples.	Ash.	Potash, K_2O.	Chlorophyll.	Total nitrogen.	Albuminoid nitrogen.	Amide nitrogen.	Albuminoids (albuminoid N. x 6.25).
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Light house, full light	3.84	0.38	6.22	1.36	1.24	0.12	7.75
Light house, in shadow	3.76	0.34	6.12	1.38	1.20	0.12	7.50
Dark house	3.26	0.15	5.02	1.34	1.01	0.33	6.31

These figures show that the plants under the electric light had reached a greater degree of maturity than those in the normal or dark house. * * *

[Dwarf peas were grown on two benches, one of which shaded about half of the other.] In the shaded portion the peas were larger and more productive than those in full light, although the latter were farther from the lamp. The average heights of plants were as follows: Light house, in full light, 4.8 inches; light house, in shade, 5.3 inches; dark house, 5.8 inches. The plants in the light house, particularly those in direct light, blossomed about a week in advance of those in the dark house, and they gave earlier fruits, but the productiveness was less, being in the ratio of 4 in the light house to 7 in the dark house. The decrease in production was due largely to the fewer number of peas in each pod, for the number of fruitful pods produced in each case was as 7 in the light house to 9 in the dark house, and there were many seedless pods in the light house. In other words, the production of pods (or flowers) was about the same in both houses, but the plants in the light house produced only four sevenths as many seeds as those in the dark compartment.

The question whether the injury was due to the electric light itself or to continuous light during the whole twenty-four hours, was tested with various plants. At first seedling radishes were covered with pots during the day and exposed to the electric light for about 12 hours at night. These made a slender and sickly growth, assuming a faint green color, and died in 3 or 4 weeks.

"The experiment was now conducted upon a larger scale, and at a time when the hours of sunlight were about equal to the hours of electric light. A tight wooden frame was placed upon the soil of a bench at one end of the light house. This frame was provided with a tight cover which was kept on during the day and removed at night." Radish seeds planted in this manner, both in soil and in pots, germinated and made a very rapid, spindling, and nearly colorless growth for a short time, but in 3 or 4 weeks the young plants were all dead. Similar results were obtained with lettuce, beans, corn, and potatoes.

Another series of tests was made by covering well-established plants in the beds. A tight box, 18 inches square and 1 foot high, was placed over certain plants during the daytime, and was removed at night and placed over contiguous plants of the same kind. Thus one set of plants received only electric light and one only sunlight, and inasmuch as both were covered during half of the twenty-four hours, any error which might have arisen from the covering itself (as lack of ventilation and increased heat) was eliminated. February 7 certain radishes in the light house which had been planted 2 weeks were covered. In 8 days some of the plants which were covered during the day were dead and the remaining ones were very weak. At the same time those which were covered during the night had made a better growth than they had before, and better than contiguous plants which had not been covered. An examination of the leaves of the plants receiving only the electric light showed that they contained no starch and very little or no chlorophyll. February 8 two lots of beans and radishes were planted in pots sunk to their brims in the soil between the radish rows in the light house. One lot was covered during the day and the other during the night, as above. Germination was the same in both lots. February 25 the daylight beans had made a stocky growth of 3½ to 4 inches, while the electric-light lot had made a weak growth of 8 to 9 inches. Radishes behaved in a similar manner. March 3 the leaves of the electric light beans began to wither, and both beans and radishes were dead March 10. The daylight lots continued to grow thriftily.

Similar experiments with plants of German ivy (*Senecio scandens*), carnation, begonia, and peas also showed the injurious effects of the electric light.

The above experiments show conclusively that within the range of an ordinary forcing house the naked arc light running continuously through the night is injurious to some plants; and in no case did we find it to be profitable. But the fact that the light hastens maturity or seed bearing suggests that a modified light may be useful under certain conditions.

Experiments with a protected light running all night.

Early in March, 1890, an ordinary white opal globe was placed upon the lamp, and for 5 weeks experiments similar to those already described were conducted. The effect of the modified light was much less marked than that of the naked light. Spinach showed the same tendency to run to seed, but to a much less extent, and the plants were not affected by proximity to the lamp. Lettuce, however, was decidedly better in the electric light house. Radishes were thrifty in the light house and the leaves did not curl, but they produced less than in the dark house, although the differences were much less marked than in the former experiments. These second series of experiments can scarcely be compared with the former ones, because of the greater amount of sunlight which the plants received in the lengthening days of spring. The figures obtained from radishes, however, may afford a practically accurate comparison because of their rapid growth.

The following figures represent the average weight in ounces of radishes in the light and dark houses, respectively: Entire plant, 0.29 and 0.33; top, 0.12 and 0.11; tubers, 0.17 and 0.22. The percentages of marketable tubers were 89 and 94.

The loss due to the electric light averages from 1 to 5 per cent in the different comparisons, while the loss occasioned by the naked light was from 45 to 65 per cent. It is also noticeable that while the tops or leaves were lighter under the naked light, they were heavier under the modified light than those of normal plants; and this is interesting in connection with the fact that lettuce did better under the modified light than in the dark house. * * *

The carrots (Shorthorn Scarlet) gave indifferent results. They did not appear to be affected greatly even by the naked light when growing directly opposite to it and but 3 or 4 feet away. Carrots require such a long period of growth that the first good picking was not obtained until the end of the experiment in April. The plants therefore grew under both the naked and protected lamps. * * * The figures [given in the article] show that the plants which grew directly in front of the lamp were but little inferior to those which stood 10 or 12 feet away, or even to those in the dark house. No other plant in our experiments has withstood the electric light so well.

Experiments with the naked light running a part of the night.—"From January 16 to May 1, 1891, the experiment was conducted under new conditions. The arrangement of the house or compartment remained as before, but the lamp was connected with a street-lighting system and the light ran but a few hours, and never on moonlight nights. In this test we used a 10 ampere 45 volt 2,000 nominal candle power Westinghouse alternating current lamp." The plants experimented with were radishes, peas, lettuce, and a variety of ornamental plants, mostly tulips, verbenas, petunias, primulas, heliotropes, and coleus.

These ornamentals were mostly named one-colored varieties, and they were grown to enable us to make observations concerning the influence of electric light upon color. In this experiment the lighting of the compartments was reversed during the last month in order to eliminate any error which might arise from any minor differences in the temperature or other conditions of the two portions of the house. [A detailed tabular record is given of the dates and hours of lighting.]

Of radishes, the White Box and Cardinal Globe were grown. The foliage was noticeably larger in the electric light house, as it had been under the modified light, but the tubers were practically the same in both houses, and the date of maturity was the same. Notwithstanding its greater size, the foliage in the light house showed some signs of curling.

American Wonder and Advance peas were grown, and in every case they were larger and more fruitful in the dark house. The electric light did not increase the size of leaves, as it did in the radishes. The results are similar to those obtained in 1890.

The lettuce, however, was greatly benefited by the electric light. We had found that under the protected light the lettuce had made a better growth than in normal conditions, but now it showed still greater difference. Lettuce of two varieties—Landreth Forcing and Tennis Ball or Boston Market—was grown. * * * Three weeks after transplanting (February 5) both varieties in the light house were fully 50 per cent in advance of those in the dark house in size, and the color and other characters of the plants were fully as good. The plants had received at this time 70½ hours of electric light. Just a month later the first heads were sold from the light house, but it was 6 weeks later when the first heads were sold from the dark house. In other words, the electric-light plants were 2 weeks ahead of the others. This gain had been purchased by 161¾ hours of electric light, worth at current prices of street lighting about $7.

This lettuce test was repeated and was watched very closely when the lamp was transferred to the compartment which had formerly been kept under normal conditions. The same results were obtained, and the differences in the two crops were so marked as to arrest the attention of every visitor. The electric light plants were in every way as good in quality as those grown in the dark house; in fact the two could not be told apart except for their different sizes.

[In another experiment where Landreth Forcing lettuce was grown] the electric-light plants were upon the benches 44 days before the first heads were sold. During

this time there were 20 nights in which the light did not run, and there had been but 84 hours of electric light, worth about $3.50. In order to compute the cost of growing lettuce by the aid of the electric light, it is necessary to know how far the influence of the light will extend. This we do not know, but the lamp exerted this influence throughout a house 20 by 30 feet, and the results were as well marked in the most remote part as they were near the lamp.

The results obtained from lettuce suggest many questions, all of which must be answered by experiment. We need to know if there is any particular time in the life of the lettuce plant when the light has a predominating influence; if a mild light is as good as a strong one; if the failure of the light during the moonlight nights is a serious drawback; to what distance the influence of the light extends; if the same results can be obtained by hanging the lamp over the house instead of inside it, and by that means lighting several houses at once; if other plants can be profitably forced by means of electric light. In all these directions, and many others, we are planning experiments for the coming years.

The influence of the light upon productiveness and color of flowers was found to vary with different species and different colors within the same species. Several named varieties of tulips gave interesting results. * * * When these came into full flower, it was found that in every case the colors were deeper and richer in the light house; but the colors lost their intensity after 4 or 5 days and were indistinguishable from those in the dark house. The plants in the light compartment had longer stems and larger leaves than the others; and there was a greater number of floriferous plants in the light. The tulips were grown at a distance of 10 and 12 feet from the lamp.

Verbena flowers near the light were uniformly injured. * * * Scarlet, dark red, blue, and pink flowers within 3 feet of the light soon turned to a grayish white, and this discoloration was noticeable to a distance of 6 and 7 feet. The plants bloomed somewhat earlier in the light house than in the other.

A few fuchsias were grown in both houses. Those in the light house were about 8 feet from the lamp, and they flowered 3 days earlier than the others. The colors were not changed.

Heliotropes of various-named varieties standing 9 and 10 feet from the lamp did not appear to be affected in any way.

White ageratums stood at 3 feet from the lamp. The flowers soon turned brown and sere. Those in the dark house remained white three times as long.

Chinese primulas at 7 feet from the light were not affected, but those 4 feet away, especially the lilacs, were changed in color. The lilac was bleached out to pure white wherever the light struck squarely upon the flowers, but any portion of the flower which chanced to be shaded by a leaf or another petal retained its color for a time and then gradually became duller. * * *

Petunias were much affected by the light. The plants were much taller and slenderer in the light, even at the farthest corners of the house, and they bloomed earlier and more profusely. * * * White petunias were not changed in color by the light, but purple ones quickly became blue, especially near the lamp. * * *

Coleus plants of various colors were placed at different distances from the lamp March 31. After 2 nights the plants within 3 feet of the lamp were much affected. Reds became yellow, browns turned green, greens lost their brightness, and dark purple became glossy black. [Plants farther away from the light changed color more slowly.]

[Observations upon the duration of flowers of various colors and species in both houses are tabulated.] Perhaps the most noticeable feature of these figures is the lack of uniformity in duration under similar conditions. Neither the distance from the lamp nor the hours of light received by the flower appears to determine the duration. The longevity of the flower is probably determined more by the vigor and general condition of the plant than by the variations in the amount of light, although this subject is one which demands closer investigation.

[Numerous auxanometer readings were made upon representative plants during 1890–91. A record of the growth of two petunia plants, alike in all respects, is given.]

The average growth per hour is as follows:

With electric light, 8 to 11 p. m., 0.0416 inches; 11 p. m. to 8 a. m., 0.0243 inches; 8 a. m. to 8 p. m., 0.0312 inches. Without electric light, 8 to 11 p. m., 0.0234 inches; 11 p. m. to 8 a. m., 0.0225 inches; 8 a. m. to 8 p. m., 0.0234 inches.

The greatest growth took place when the electric light was burning.

In all these experiments with ornamental plants it was noticeable that the light exercised a very injurious effect within a radius of about 6 feet. Between 6 and 8 feet the results were indifferent, and beyond that point there was usually a noticeable tendency towards a taller and straighter growth, and it seemed to us that at distances of a dozen feet or more the flowers were more intense in color, particularly when they first opened. There was usually a perceptible gain in earliness in the light house also. On the whole, I feel that it will be possible some day to use the electric light in floricultural establishments to some pecuniary advantage.

Experiments elsewhere.

The first experiment to determine the influence of electric light upon vegetation was made by Hervé-Mangon in 1861.* This experiment showed that the electric light can cause the production of chlorophyll or the green color in plants, and also that the light can produce heliotropism, or the phenomenon of turning or bending towards the light.

In 1869 Prillieux † showed that the electric light, in common with other artificial lights, is capable of promoting assimilation, or the decomposition of carbon dioxide and water.

[The only other important investigations of the subject from a horticultural standpoint appear to have been those of C. W. Siemens in England, and P. P. Dehérain in France.] Dr. Siemens's experiments ‡ may be divided into two series; in one series the lamp was placed inside the greenhouse and in the other suspended over it.

[In his first experiment a lamp of 1,400 candle power was used. The foliage of melon and cucumber plants placed within 3 or 4 feet of this lamp was much injured. When the plants were removed to a distance of 7 or 8 feet they showed signs of recovery and made new leaves.] In general all plants which were exposed to normal conditions during the day and to 6 hours of electric light at night "far surpassed the others in darkness of green and vigorous appearance generally." The flavor was fully as good in the electric-light fruits as in the others. These results were supplemented by a larger experiment in the winter of 1880–81. In this case a lamp of 4,000 candle power was used, and it was placed inside a house of 2,318 cubic feet capacity. The light was run all night and the arc was at first not protected by a globe. The "results were anything but satisfactory," the plants soon becoming withered. At this point a globe of clear glass was placed upon the lamp, and thereafter the most satisfactory results were obtained. Peas, raspberries, strawberries, grapes, melons, and bananas fruited early and abundantly under continuous light—solar light by day and electric light by night. The strawberries are said to have been "of excellent flavor and color," and the grapes of "stronger flavor than usual." The bananas were "pronounced by competent judges unsurpassed in flavor," and the melons were "remarkable for size and aromatic flavor." Wheat, barley, and oats grew so rapidly that they fell to the ground from their own weight. The beneficial influence of the clear glass globe was therefore most marked. * * *

In the other series of experiments Siemens placed an electric lamp of 1,400 candle power about 7 feet above a sunken melon pit which was covered with glass. The

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*Compt. rend., 53, 243.

†Compt. rend., 69, 410.

‡Proc. Roy. Soc., 30, 210, 293. Rep. British A. A. S., 1881, 474. See also abstract in Nature, 21, 456 (Mar. 11, 1880), and an editorial in the same issue.

light was modified by a clear glass globe. In the pit seeds and plants of mustard, carrots, turnips, beans, cucumbers, and melons were placed. The light ran 6 hours each night and the plants had sunlight during the day. In all cases those plants "exposed to both sources of light showed a decided superiority in vigor over all the others, and the green of the leaf was of a dark, rich hue." Heliotropism was observed in the young mustard plants. Electric light appeared to be about half as effective as daylight. A great difficulty experienced in this experiment was the film of moisture which condenses on greenhouse roofs at night and obstructs the passage of light. The light was at one time suspended over two parallel pits nearly 4 feet apart, and the effect was observed upon plants under the glass and in the uncovered space. In all cases the growth of the plants was hastened. Flowering was hastened in melons and other plants under the glass. Strawberries which were just setting fruit were put in one of the pits and part of them were kept dark at night while others were exposed to the light. After 14 days, the light having burned 12 nights, most of the fruits on the lighted plants "had attained to ripeness, and presented a rich coloring, while the fruit on those plants that had been exposed to daylight only had by this time scarcely begun to show even a sign of redness." He concludes that a lamp of 1,400 candle power produced a maximum beneficial result on vegetation at a distance 3 meters (nearly 10 feet) above the glass, but "the effect is nevertheless very marked upon plants at a greater distance."

At the close of his experiments Siemens was very sanguine that the electric light can be profitably employed in horticulture, and he used the term "electro-horticulture" to designate this new application of electric energy. * * *

Dehérain's experiments* were conducted at the Exposition d'Electricité, Paris in 1881. A small conservatory standing inside the Exposition building was divided into two compartments. One compartment was darkened and the glass painted white upon the inside; this received the electric light and all solar light was excluded. The other compartment was not changed. * * *

A lamp of 2,000 nominal candle power was used. At first the naked electric light was used and it ran continuously.

[A number of different kinds of plants were experimented with.] At the expiration of 2 weeks the condition of the plants was so bad that a change was made, and thereafter a transparent glass globe was used upon the lamp.

[From his experiments Dehérain drew the following conclusions:]

(1) The electric light from lamps contains rays harmful to vegetation.

(2) The greater part of the injurious rays are modified by a transparent glass.

(3) The electric light contains enough rays to maintain full-grown plants 2½ months.

(4) The light is too weak to enable sprouting seeds to prosper or to bring adult plants to maturity.

Finally, observations† were made more recently upon the influence of the electric light upon plants in the Winter Palace at St. Petersburg. It was observed that in a single night ornamental plants turned yellow and then lost their leaves. Yet it is well known that incandescent lamps can be lodged in the corolla of a flower without injuring it.

Recapitulation.—The author does not consider that the results thus far obtained will warrant many definite conclusions.

Yet there are a few points which are clear: The electric light promotes assimilation, it often hastens growth and maturity, it is capable of producing natural flavors and colors in fruit, it often intensifies colors of flowers, and sometimes increases the production of flowers. The experiments show that periods of darkness are not necessary to the growth and development of plants. There is every reason, therefore, to suppose that the electric light can be profitably used in the growing of plants.

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*Ann. Agron., 7, 551 (1881). † Ann. Agron., 14, 281 (1888).

It is only necessary to overcome the difficulties, the chief of which are the injurious influences upon plants near the light, the too rapid hastening of maturity in some species, and in short the whole series of practical adjustments of conditions to individual circumstances. Thus far, to be sure, we have learned more of the injurious effects than of the beneficial ones, but this only means that we are acquiring definite facts concerning the whole influence of electric light upon vegetation; and in some cases, notably in our lettuce tests, the light has already been found to be a useful adjunct to forcing establishments.

The experiments bring out more clearly the fact that the growth of plants may be continuous, and show that the injury to plants from the electric light can not result from any gases arising from the lamp itself.

It is highly probable that there are certain times in the life of the plant when the electric light will prove to be particularly helpful. Many experiments show that injury follows its use at that critical time when the plantlet is losing its support from the seed and is beginning to shift for itself, and other experiments show that good results follow its later use. This latter point appears to be contradicted by Dehérain's results, but his experiments were not conducted under the best normal conditions.

On the whole, I am inclined towards Siemens's view—that there is a future for electro-horticulture.

New York Cornell Station, Bulletin No. 31, September, 1891 (pp. 17).

THE FORCING OF ENGLISH CUCUMBERS, L. H. BAILEY, M. S. (pp. 125–139, figs. 7).—An account of experiments by the author in raising English cucumbers in the greenhouse during the winter of 1890–91 with a view to encouraging their introduction in this country. The bulletin contains descriptions of the greenhouse used; methods of culture and training; and notes on the appearance and history of the English varieties, on pollination and crossing, and on the insect enemies of cucumbers. For details regarding the general requirements of houses, temperature, and moisture for the forcing of cucumbers, the reader is referred to Bulletins Nos. 25 and 28 of the station (see Experiment Station Record, vol. II, p. 507, and vol. III, p. 91), in which experiments with beans and tomatoes are reported. Some attempts were made to obtain a variety of English cucumbers suitable for out-door use by crossing the Sion House and Medium Green varieties.

Fruits of unusual promise have been obtained, but they have not produced good seeds. Some of the mongrel fruits developed a peculiar weakness in the tendency of the placentæ or cell walls to decay. The seeds did not mature and the soft, pulpy tissue about them solidified. Near the apex of the fruit the placentæ tended to break away from the body, and in the cavities decay set in and extended finally to the base of the fruit. All the fruits upon one of the mongrel plants behaved in this manner. In no case had the fruit been injured nor was the decay visible upon the exterior until it had extended well down the fruit. I am unable to account for it.

In most instances the mongrel vines resembled the Medium Green (the staminate parent) more than the Sion House. The fruits were generally intermediate, although almost every gradation was observed. Sometimes the fruits would vary widely upon the same plant. A number of vines bore beautiful fruits, twice as long as the Medium Green, nearly cylindrical, with very few spines, and we are looking for good results from this cross.

The following summary is taken from the bulletin:

(1) The English forcing cucumber demands a rather high temperature [60° to 65° F. at night, and 70° to 75° by day], brisk bottom heat, abundance of water, and a very rich soil.

(2) Great care should be exercised to maintain a vigorous growth from the start, and particularly to avoid injury from insects and mildew.

(3) In this latitude English cucumbers produce marketable fruits from the seed in from 80 to 100 days.

(4) The plants must be trained. Two or three strong arms may be allowed to each root, and these should be stopped as soon as they reach the space allotted to adjoining plants. Part of the young growth should be removed, and in midwinter, especially in dark houses, some of the leaves may be removed to advantage.

(5) The fruits should not be allowed to lie upon the soil, and the heavy ones are sometimes supported in a sling to prevent injury to the vines.

(6) Sion House, Telegraph, Kenyon, and Lorne are good varieties. The fruits, especially of the longer sorts, are usually marketed before they attain their full size.

(7) The English forcing cucumber has been produced by selection from shorter and spiny field sorts within recent times.

(8) Hand pollination appears to be essential upon the first flowers; but cucumbers set and mature with no pollen whatever, though in that case fruits are usually later and probably fewer. Pollination must be employed when seeds are desired.

(9) Seed bearing is not necessarily associated with deformity of fruits, although upon some plants it appears to conduce to the production of swollen ends, which, however, appear to be avoided by swinging the fruits.

(10) The spotted mite and aphis (*Aphis rumicis?*) can be destroyed by Hughes's Fir Tree Oil, and the powdery mildew (*Oidium erysiphoides*, var. *cucurbitarum*) is kept in check by fumes of sulphur and by the ammoniacal carbonate of copper.

North Carolina Station, Bulletin No. 78*a* (Meteorological Bulletins Nos. 19 and 20), July, 1891 (pp. 34).

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, H. B. BATTLE, PH. D., AND C. F. VON HERRMANN.—Notes on the weather, and tabulated summaries of meteorological observations of the North Carolina weather service, coöperating with the United States Weather Bureau, for April and May, 1891.

Ohio Station, Bulletin Vol. IV, No. 3 (Second Series), August 1, 1891 (pp. 20).

COMMERCIAL AND OTHER FERTILIZERS ON WHEAT, C. E. THORNE AND J. F. HICKMAN, M. S. A. (pp. 57–71).—This bulletin contains an account of the second and third years' experiments with wheat on the same plats, the object being to test the profitableness of using fertilizers for wheat on Ohio soils, and the special needs of the soil for this crop. The land used contained 22 tenth-acre plats, separated from each other by intervening strips 2 feet wide, and had been in clover in 1887. The fertilizers applied per acre each year were as follows: Dissolved boneblack 320 pounds, muriate of potash 160 pounds, and nitrate of soda 160 pounds, were used alone and combined two by two,

and all three together; the boneblack and muriate of potash combined in the same amounts were used with 320 pounds and 480 pounds of nitrate of soda and 120 pounds of sulphate of ammonia, respectively; muriate of potash and nitrate of soda, 160 pounds each, were used with 300 pounds of dissolved South Carolina rock and 400 pounds of ground Thomas slag, respectively; and barnyard manure 8 tons and linseed meal 1,800 pounds were each used on one plat. Each plat received the same fertilizers as in the preceding year; and as before, 8 plats remained unmanured.

Penquite Velvet Chaff wheat was sown on all the plats the last of September in each year, the fertilizers being applied broadcast just before seeding, except the nitrate of soda, which was applied the following April.

An experiment on a similar plan was made in Columbiana County in 1890.

The results of all three experiments are tabulated and discussed, and reference is made to the Rothamsted experiments with fertilizers for wheat. The results are also reported of a trial at the station in which wheat was grown in a rotation, being preceded by corn and oats. The authors' conclusions from the several experiments follow:

In 1890 the various fertilizers used produced in every case some increase of crop. When nitrate of soda was used alone its cost was recovered in the increase of crop, counting wheat at $1 per bushel, but in no other case in the station test was the cost of any of the fertilizers or combinations of fertilizers recovered, except in that of barnyard manure.

In the test in Columbiana County the increase of crop on plat 2 apparently justified the use of superphosphate, but this increase was not confirmed by the duplicate plats 5 and 8; hence we are led to doubt whether this increase may not have been due to the natural superiority in the soil of this plat. In general the fertilizers added less to the unaided yield of the Columbiana County soil than they did to that of the station soil, notwithstanding the fact that the unfertilized plats on the station farm yielded twice as much wheat on an average as did those on the farm in Columbiana County.

In the tests of 1891 at the station the fertilizers have in every case caused a decrease of crop where superphosphate was used. Nitrate of soda, alone or with potash, has produced a slight increase; but in no case has the increase been sufficient to justify the use of the fertilizer, and this applies both to the wheat grown continuously on the same soil and to that grown in rotation.

In the tests of 1891 the wheat grown in rotation without fertilizers has yielded as large an average crop as the best obtained from the use of the fertilizers in 1890, although the yield from the unfertilized plats under continuous cropping was practically the same in both seasons.

SOME FERTILIZING MATERIALS AND THEIR USES, C. E. THORNE AND J. F. HICKMAN, M. S. A. (pp. 71–76).—A popular discussion of the commercial sources of nitrogen, phosphoric acid, and potash, and the use of these various materials.

Ohio Station, Bulletin Vol. IV, No. 4 (Second Series), August 25, 1891 (pp. 23).

Experiments in wheat seeding and treatment of seed for smut, J. F. Hickman, M. S. A. (pp. 77–89).—These included experiments in (1) thick and thin seeding, (2) seeding at different depths and by different methods, and (3) treatment of seed with copper sulphate solutions and hot water for smut. The first two were in continuation of experiments recorded in previous publications of the station. Accounts of these experiments in 1889 and 1890 are given in Bulletin vol. II, p. 115, and vol. III, p. 175, of the station (see Experiment Station Record, vol. I, p. 287, and vol. II, p. 249).

Thick and thin seeding.—In 1891 this experiment was conducted on light clay loam, with a gravel subsoil, which had been cropped with wheat for 9 successive years. Results are tabulated for Velvet Chaff (Penquite) and Deitz varieties. Owing to the ravages of the wheat midge, which were greater in the case of the Velvet Chaff, the results obtained from the two varieties are not comparable. The yields in 1891 ranged from 26 bushels per acre for the 2-peck rate to 28.8 bushels for the 6-peck rate. For the 10 years the 7-peck rate has given the highest average yield (37.9 bushels), but is closely followed by the 5 and 6 peck rates (37.4 and 36.4 bushels). "Seeding above 7 pecks per acre gives fewer bushels but a superior quality of grain."

Methods of culture and different depths of seeding.—The results obtained by different methods of seeding, mulching, and planting at different depths are given in one table for 1891 and in another for seven seasons. The variety of wheat used in 1891 was Martin Amber. In 1891 the yields from planting at depths of from 2 to 4 inches were nearly the same. "Broadcast seeding has given as good results this year as drilling, but in a series of years drilling has produced the largest crop. Very light mulching has apparently been of some benefit this year. Heavier mulching has invariably injured the crop. Cross-drilling has shown no advantage this year. No larger crop has been produced this year from mixed seed of two varieties than from pure seed of the same varieties sown separately."

Treatment of seed to destroy smut germs.—Notes and tabulated data for an experiment in which wheat seed was immersed for 10 minutes in sulphate of copper solutions (12 gallons of water to from 2 to 12 ounces of copper sulphate), and in hot water (124° to 152° F.). Both treatments were effective, but that with hot water (132° to 135° F.) is much more economical.

Comparative tests of varieties of wheat, J. F. Hickman, M. S. A. (pp. 89–97).—These were in continuation of the tests reported in Bulletin vol. III, p. 184, of the station (see Experiment Station Record, vol. II, p. 250). In 1891 the test was on river bottom land, with 52 varieties on clover sod and 11 on wheat stubble. Tabulated data are given for the 63 varieties tested this year and for 16 varieties tested during 7 years.

Wheat, comparative yield of varieties for 7 years.

[Bushels per acre.]

Varieties.	1884.	1886.	1887.	1888.	1889.	1890.	1891.	Average.
Valley	38.1	45.8	34.9	33.6	44.5	36.1	39.5	38.9
Red Fultz	38.2	54.0	35.2	30.9	37.3	32.5	32.4	37.2
Diehl-Mediterranean	39.2	42.7	26.9	34.1	42.0	27.5	37.6	35.7
Royal Australian	40.2	49.6	38.8	18.1	45.6	32.6	24.5	35.6
Nigger	36.6	51.0	24.6	32.0	40.6	31.7	31.6	35.4
Egyptian	30.6	41.7	28.0	32.2	46.1	34.0	37.2	35.4
Poole	32.6	61.2	25.5	17.5	43.6	29.6	35.9	35.1
Penquite Velvet Chaff	33.3	42.9	37.4	26.6	41.3	35.2	27.9	34.9
Silver Chaff Smooth	39.7	45.2	30.0	31.4	37.8	29.5	30.1	34.8
Tasmanian Red	49.6	45.6	22.1	25.0	37.1	29.3	33.1	34.5
Democrat	35.9	40.4	24.5	25.0	45.3	30.4	38.1	34.2
Martin Amber	45.2	36.7	21.4	28.2	47.8	29.1	28.8	33.9
Theiss	29.4	46.2	29.5	36.8	37.8	25.4	30.5	33.7
Fultz	36.7	38.4	....	23.1	30.1	34.2	35.6	33.0
Landreth	31.6	39.9	32.0	25.6	41.1	....	25.3	32.6
Mediterranean	31.0	38.7	22.3	28.2	36.8	29.3	34.5	31.5
Mean	37.2	45.0	28.9	28.0	40.9	31.9	32.7	34.8

"Among the newer varieties Mealy and Rudy are the most promising. * * * The variations in weight per measured bushel in the several varieties between the screened and unscreened grain has run from nothing in some varieties up to 13 per cent in others. The proportion of straw to grain was greater this year on land where wheat had been grown for 10 years than it was on land where a system of rotation had been followed."

Rhode Island Station, Bulletin No. 10, May, 1891 (pp. 7).

Mixed food in cases of faulty appetite in horses and neat stock, F. E. Rice, M. R. C. V. S. (pp. 125–128).—The causes of loss of appetite by farm stock are briefly discussed and formulas for condimental foods are given.

The following formula is useful in the greater number of cases: Ground or crushed oats and corn meal of each 5 pounds, oil meal 0.25 of a pound, common table salt 2 ounces. If the animal seems in need of a tonic or is troubled with intestinal worms, there may be mixed with each ration, as above given, a desertspoonful of powdered gentian and a small teaspoonful of the dried sulphate of iron: these are to be had of any druggist.

Sore shoulders or collar galls in horses, F. E. Rice, M. R. C. V. S. (pp. 128, 129).—The causes and treatment of collar galls in horses are briefly discussed. The author advises the employment of a cast-iron collar, such as is coming into use in some places, to prevent galling the shoulders.

South Carolina Station, Bulletin No. 1 (New Series), July, 1891 (pp. 15).

Fertilizer analyses.—Tabulated data for analyses of 118 samples of ammoniated fertilizers, 57 of acid phosphate (with or without potash), 30 of cotton-seed meal, and 16 of kainit. Nine of the fertilizers analyzed were found below guaranty in one or more ingredients.

Texas Station, Bulletin No. 15, May, 1891 (pp. 16).

INFLUENCE OF CLIMATE ON COMPOSITION OF CORN PLANTS, H. H. HARRINGTON, M. S. (pp. 77–86).—This experiment was made with a view to determining the variation in the composition of the same varieties of corn when grown in different sections of the country. The plan of the experiment originated with the Texas Station. Seed corn raised in Wisconsin, New York, Maryland, Kansas, Kentucky, Texas, and Georgia, one variety from each State, was sent to the stations in Mississippi, Maryland, Georgia, Connecticut, New York, Wisconsin, and Kansas in the spring of 1890, for planting. Analyses were to be made by the Texas and the Connecticut State Stations of the seed corn used and the crop secured in each of the States. For various reasons reports were only received from Connecticut, New York, and Georgia. The 7 varieties of corn grown in New York and Georgia and 2 grown in Connecticut were analyzed by the Texas and Connecticut State Stations, and the results are reported in the bulletin. Considerable discrepancies are noticeable between these two sets of analyses. Only the analyses by the Texas Station will be considered here.

The corn raised in New York from seed grown in Kentucky, Maryland, and Texas was lower both in protein and fat than the seed from which it came, and that grown from Wisconsin, Kansas, and Georgia seed showed a slight increase in protein but a decline in fat. The corn raised in Georgia from seed grown in New York, Kansas, and Kentucky was lower than the seed corn in both protein and fat, and that from Wisconsin seed was slightly richer than the seed in both these constituents. No wider differences were presented than those between corn raised from the same variety of Northern-grown seed in Connecticut and New York, as will be seen from the following example:

Composition of dry matter of corn grown in different States.

	Seed corn grown in Wisconsin.	Corn from same seed raised in—		
		Connecticut.	New York.	Georgia.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Crude ash	1.39	1.53	1.71	1.02
Crude cellulose	2.41	2.29	2.67	1.83
Crude fat	4.76	5.59	4.62	5.43
Crude protein	11.29	9.07	12.24	11.60
Nitrogen-free extract	80.15	81.52	78.76	80.12
Total	100.00	100.00	100.00	100.00

The corn grown in Georgia from Georgia seed likewise showed considerable variations in composition from the seed. It is obviously impossible to make any general deductions as to the influence of locality on the composition from the data at hand.

DIGESTIBILITY OF FEEDING STUFFS (pp. 86–88).—Partial data are given for tests of the digestibility of cotton-seed hulls and corn fodder by means of feeding experiments with cattle. Analyses are given of the cotton-seed hulls and the corn fodder fed.

COMPARATIVE ASH DETERMINATIONS, D. ADRIANCE, M. S. (p. 89).—This is a comparison on 16 samples of feeding stuffs of the percentage of ash obtained (1) by the official method for 1890, (2) by burning in a muffle furnace, and (3) by moistening the material with sulphuric acid and then burning over a direct flame. "The work clearly shows that the methods are comparable only in exceptional cases."

MISCELLANEOUS ANALYSES (pp. 89, 90).—Analyses of 6 samples of fertilizers, 1 sample of water, and 1 of roasted cotton seed.

Texas Station, Bulletin No. 16, June, 1891 (pp. 15).

WORK IN HORTICULTURE, S. A. BEACH, B. S. A. (pp. 93–105).—A brief preliminary report is given on experiments in tile drainage for potatoes, cabbages, and strawberries. The method of setting strawberry plants employed at the station is described. A number of foreign varieties of apples, peaches, pears, cherries, and ornamental trees and shrubs have been received from the collection of the Iowa Agricultural College for propagation and distribution in Texas. Brief descriptive notes on these varieties are compiled from the publications of the Iowa Station and College. The list of fruits on trial at the station, as given in this bulletin, includes 167 varieties of peaches, 68 of plums, 32 of cherries, and 113 of apples. The list of trees and shrubs which have been grown successfully during the past 2 years at the station includes 42 species of forest and shade trees, 17 of conifers, and 31 of shrubs and small trees.

Vermont Station, Bulletin No. 26, September, 1891 (pp. 23).

MAPLE SUGAR, W. W. COOKE, M. A., AND J. L. HILLS, B. S. (pp. 39–59).—This includes extracts from the act of Congress of October 1, 1890, giving the conditions under which the bounty on maple sugar will be paid by the National Government; the composition of maple sap; descriptions of the polariscope and the hydrometer, and of the methods of testing with these instruments and with the thermometer; methods of analysis used by the station; the percentages of sugar in samples of Vermont maple sirup at different times in the season, as determined at the station; the effect of stirring or granulating the sirup on the per cent of sugar; the effect of draining sugar; the quality of ordinary Vermont sugar; tables for determining the relative value of sirup according to the temperature of its boiling point; and a discussion of the relative profitableness of sirup and sugar. The following

table gives the relative value per gallon of sirup containing different percentages of sugar, as calculated by the authors:

Degrees Baumé hydrometer.	Specific gravity.	Degrees Brix hydrometer.	Approximate per cent of pure sugar.	Temperature of boiling point.	Weight per gallon.	Relative value per gallon.
				Degrees F.	*Pounds.*	
25	1.205	44.9	41	215.0	10.0	68
26	1.215	46.8	43	215.1	10.1	72
27	1.226	48.7	45	215.3	10.2	75
28	1.236	50.5	47	215.6	10.3	78
29	1.246	52.4	49	215.9	10.4	82
30	1.257	54.3	51	216.2	10.5	85
31	1.268	56.2	53	216.6	10.6	88
32	1.279	58.1	54	217.0	10.7	90
33	1.290	60.0	56	217.4	10.7	93
34	1.302	62.0	58	218.1	10.8	97
35	1.313	63.9	60	218.6	10.9	100
36	1.325	65.8	62	219.5	11.0	103
37	1.337	67.8	64	220.3	11.1	107
38	1.350	69.8	66	221.2	11.2	110
39	1.362	71.8	68	222.0	11.3	113
40	1.374	73.7	70	223.2	11.4	117
41	1.387	75.7	72	224.5	11.6	120
42	1.400	77.7	74	226.0	11.7	123
43	1.415	79.8	75	227.8	11.8	125
44	1.428	81.8	77	229.7	11.9	128
45	1.442	83.9	79	231.8	12.0	132
46	1.457	86.0	81	234.0	12.1	135
47	1.471	88.1	83	236.3	12.3	138
48	1.486	90.2	85	238.7	12.4	142

The per cents of sugar given above are calculated for a fairly good sirup. The relative values in the last column are based on these per cents, but will be nearly the same for all except the poorest of sirups. The relative value is made use of as follows: A weight of 11 pounds per gallon and 33° Baumé is taken as the standard. Dividing the weight of the sirup by 11 gives the number of standard gallons. Multiplying the price that is to be paid for 11-pound sirup by the relative value figure and dividing by 100 gives the price to be paid per standard gallon.

[The following are the general conclusions from the investigations at the station on maple sugar:]

(1) An accurate thermometer is the sugar maker's best guide in determining how to handle his sirup to make a sugar that will draw the bounty.

(2) When sap begins to boil its temperature is about 213° F.; as it boils down and becomes thicker the temperature at which it boils rises, until towards the end it may be 235°–240° F., or even as high as 245° F.

(3) If the sirup had nothing in it but sugar and water, at a temperature of 230° F. it would test 80°, and at 253° F. it would test 90°. A degree means 1 per cent of sugar.

(4) The sirup also contains mineral matter, malate of lime ("niter" or "sugar sand"), burnt sugar, and toward the end of the season various materials resembling glucose, due to the starting of the buds and the beginning of the summer's growth of the tree.

(5) These extra materials at the beginning of the season are about one sixteenth the weight of the sugar, and increase until in some very poor and black "last run" they may amount to 30 pounds for every 100 pounds of actual sugar present.

(6) Hence 100 pounds of a first-class sirup boiling at 228° F. instead of containing 80 pounds of sugar, contains about 75 pounds of sugar and enough of the other materials (5 pounds) to make up the 80 pounds, the other 20 pounds being water.

(7) Such a sirup will have to be heated to 231° F. and some more of the water driven off before it will contain 80 per cent of actual sugar, and to 243° F. to contain 90 per cent sugar.

(8) The more the impurities the higher the temperature to which the sirup will have to be heated.

(9) To make a sugar testing 80° by the polariscope, "first run" sirup will have to be heated to 233° F. The general run of good quality sirup through the most of the season will need to be heated to 235° F., and if it is a little dark, to 236° F. Toward the latter part of the season the temperature will need to be raised to 238° F., and the same should be done at any time when a sirup gets scorched or for any reason seems to be of poor quality. This is always on the supposition that the sirup is stirred until it grains, according to the ordinary custom in Vermont, before it is poured into the tubs or pails. If the malate of lime is not removed these temperatures will need to be raised 2°.

(10) The "last run" can not be made into a sugar testing 80°. This is always true after the buds start, and usually the case with the one or two runs next previous.

(11) A sugar containing 90 per cent of pure sugar can be made only from the best of sirup in the first half of the season. The sirup to make it will have to be heated to 242° F.

(12) The sirup that will make 100 pounds of sugar testing 80° and drawing a bounty of $1.75, will make 88 pounds of sugar testing 90° and drawing a bounty of $1.76, a loss of 12 pounds of sugar to gain one cent in bounty.

The 90° sugar will need to be sold at 1 cent a pound higher than the 80° to make up for the loss in weight. Hence do not try to make a 90° sugar for the sake of getting the 2 cents a pound bounty, unless you have a special market that will pay you at least 1 cent a pound extra for the hard sugar.

(13) A sirup boiling at 219° F. has a specific gravity of 1.325 and weighs just 11 pounds to the gallon. This will not granulate under ordinary conditions, but at 220° F. crystals of sugar will begin to form.

(14) A sirup weighing 11 pounds to the gallon will, if of good quality, make 8¾ pounds of sugar testing 80° and drawing a bounty of 15 cents, or 7¾ pounds of sugar testing 90° and drawing the same bounty.

Wisconsin Station, Bulletin No. 28, July, 1891 (pp. 16).

CONSTRUCTION OF SILOS, F. H. KING.—This article is based on observations on 93 silos, "of which 70 are in Wisconsin, 6 in Michigan, 6 in Ohio, and 11 in Illinois. Of these, 67 are lined wholly or in part with wood; 10 are lathed, and plastered with water-lime; 14 are stone, grout, or brick, with cement facing; 2 are lined with metal, and 1 with tar paper."

Wood-lined silos.—Of the 67 silos lined wholly or in part with wood 34, or more than one half, showed some rotting at the time of the examination. The oldest of these silos have been filled only five seasons; 7 are rotting at the end of the second filling; and 1, which was relined at the end of 3 years, has the new lining rotting after a single year's use. This appears like a dark record for the wood-lined silos, but there is a brighter side when the subject is studied in detail.

We have found five varieties of wood lining now in use, as follows:

(1) A single layer of matched boards, in 2 silos. One of these is rotting where it comes against a beam in the barn and the other has been used 1 year only. In the latter the silage spoiled 1 foot in at the corners and from 2 to 4 inches on the sides.

(2) Two layers of common boards without paper and unpainted. But one of these was examined and this was rotting in several places after 3 years' service. The silage had spoiled to a considerable extent in it, but it should be said that it was built of cull boards, many of which were worm-eaten and even spongy in places.

(3) Two thicknesses of boards separated by strips of furring laid upon tar paper. Of the 6 silos containing this type of lining, their average age being 3.33 years, every one has rotted, 2 of them so badly as to require extensive repairs before the silos are suitable for service again.

(4) One thickness of matched boards with paper on the studding. Thirteen of these silos have been visited, 6 of which, with an average age of 3 years, are in good condition still, while 7, with an average age of 3.43 years, are rotting more or less.

(5) Two thicknesses of boards with paper between, nailed closely and firmly together. There are 45 of these silos, 26 with an average age of 3 years, in good condition, while 19, with an average of 3.4 years, are rotting to some extent.

The rotting in most of the cases noted is by no means general, and the conditions under which it has occurred may be thus stated: (1) Where there has been inadequate general ventilation, 8; (2) where stone walls have been faced with wood, 8; (3) where boards came against beams or sills, 12; (4) where spoiled silage is left piled against the boards, 4; (5) where dirt is piled against or lies behind the lining, 4.

I believe that the rotting in every case we have thus far observed in the walls of wood silos is attributable to imperfect ventilation, and that it might have been greatly delayed, if not entirely prevented, by different methods of construction. * * *

The linings of wood silos have been painted in various ways to render them less liable to rot, as follows: (1) Paint of any kind, (2) with hot coal tar, (3) with coal tar dissolved in gasoline, (4) with hot coal tar mixed with pitch, (5) with pitch alone, (6) with linseed oil and red ocher, (7) with linseed oil alone.

As far as can be deduced from a study of the silos visited, there appears to be very little if any advantage derived from the use of the paints mentioned.

Painting may even hasten decay. Some antiseptic liquid might be used, but tests are required to determine what is a good preparation for this purpose.

Stone and grout silos.—We have examined 14 silos which are stone or grout and 25 which are stone or grout below and wood above. The masonry of nearly all of these silos is plastered with one or more coats of some variety of water lime or cement, and where the work is well done the great majority of the testimony goes to show that the silage in contact with the masonry is just as good or even better than against the wood. * * * While it is true that the acids of the silage decompose the cement of the stone silos, still the life of a single heavy coat, well put on and protected from frost, appears to be at least 10 years, and with a yearly whitewashing with pure cement, I have no doubt that a single coat of plastering might last 20 to 30 years.

Where the walls of stone silos have been left rough and uneven through insufficient pointing or not plastering them, the settling of the silage develops air spaces against the walls, which result in more or less silage spoiling; this fact coupled with another, viz, that the earlier stone silos were comparatively shallow, has been, in my judgment, the chief cause of unfavorable criticism of these structures. The only serious objection I can urge against a well-built stone silo is its relatively high first cost.

Silos lined with other materials.—The 10 lathed and plastered silos examined all showed cracks and the disintegrating effects of the acids in the silage. Serious objections to this kind of lining are stated.

At the station are 2 silos lined with metal, 1 with sheet iron and the other with roofing tin. They have each been in use 1 year, and in my judgment are not likely to prove satisfactory. None of the available metals are in themselves proof against the acids of the silo, and it is difficult to coat them in such a way as to entirely shut off the acids. * * *

I have seen but 1 paper-lined silo, and it is very unsatisfactory. * * *

The 2 shingled silos were in a fair state of preservation, and the silage is reported to have kept well in them. In these cases cull shingles had been used at 60 cents per thousand.

Such a lining is necessarily less perfect, and I believe not as lasting as plain

boards, and when good shingles are compared with good lumber the lumber is cheaper.

As a result of his observations and experience the author believes that the silo should be not less than 24 feet deep, and either round or as nearly square as practicable, because "these forms give the greatest capacity with the least amount of side exposure."

In the construction of silos careful attention should be paid to the area of surface exposed in feeding the silage. Silage wastes much more rapidly when fed from the sides than from the top, and since the most economical construction demands the largest possible feeding surface, it follows that the feeding should be, in general, from the top.

The proper horizontal area of the feeding pit depends upon the amount of silage fed daily and the rate at which silage becomes seriously injured when exposed. I have not been able to gather facts enough to settle this important point. The spoiling is certainly more rapid in the shallow than in the deep silos, and more rapid when corn or clover is put in whole than when cut, because it is impossible to feed the surface down as evenly and keep it as smooth. My impression is that the silage should be lowered at least 2 inches daily, and that 3 would be better. Taking 3 inches as the depth fed daily, 40 as the number of animals, 150 days as the feeding period, and 1.5 cubic feet as the amount fed to each animal daily, a round silo 17.5 feet inside diameter and 37 feet deep would be required. The same conditions would also be met by a round silo 22 feet inside diameter, 24 feet deep, with a partition through the center.

Where all the silage can be fed conveniently from one point and a large amount of silage must be stored, one silo with partitions is not only much cheaper but better than separate structures, because the additional corners can not admit air from the outside when the pits are full and the round silo with partitions makes less corners than the rectangular ones do.

Two-inch partitions give ample strength where the filling takes place on both sides at once; and if it is desired to fill one pit faster than the other, temporary braces may be placed in the empty pit and removed as it is filled. I believe that two thicknesses of boards with paper between make a better partition than the 2-inch plank, which appear to be more commonly used.

Whatever tends to the expulsion and exclusion of entangled air must conserve the silage, and whatever tends to leave or form cavities in which air can lodge in bulk, experience shows, leads to spoiled silage. Cross rods, overhanging ledges, and projecting stones should be avoided, as they hold up the silage, forming cavities into which air collects, enabling the molds to grow.

When the feeding of the silage does not begin very soon after the completion of the filling, a good covering lessens the waste. I have found the following practices in regard to covering:

(1) Some do not cover at all and have 6 to 12 inches of waste.

(2) Some have used straw with no gain and possibly greater loss.

(3) Many use green marsh hay, cut, and sometimes wet, with good results.

(4) A few use chaff with good results.

(5) One has used boards covered with 8 inches of dry earth, which is used afterwards in the stables as an absorbent. Silage keeps well.

(6) One used straw and weighted with stone with poor results.

(7) Some use cut marsh hay covered with plank, the cracks between planks covered with boards, and the whole weighted with stone. Little loss except at edges and corners.

(8) Others use a layer of cut straw, then boards, then tar paper and boards again. Keeps perfectly except at edges and corners.

(9) Still others have used first paper, and then boards, weighted with stone, with good results.

The testimony in regard to covering is quite discordant. Some claim good results with a given method, while with others it has failed. Some have good results one season and very different results another with the same method. We need much more positive knowledge on this point than is now available.

Nine of the silos examined have been infested by rats. * * * The surest safeguard against them appears to be covering the bottom of the silo with a layer of small stones or grout before the cement is applied. * * *

The general verdict is that the freezing, so far as silage is concerned, is more an inconvenience than serious loss. * * *

At present prices there is no available material on the market which can compare with wood in cheapness of first cost, and if a mode of construction can be devised which will insure permanency to the framework, and at the same time give an effective service of say 10 years to the lining, the essential demands of a material for silo building will be met by it.

[The following conditions essential to durability are stated:] Only sound and well-seasoned lumber should be used. * * * Wherever the conditions are for the rotting of silage there it is quite possible for the silo lining also to rot, as my observations have shown, and since ample depth insures better silage, it may also be expected to better preserve the lining. * * *

[Since silage is most apt to spoil in the corners of the silo, the round form of silo is deemed preferable.] Perfect ventilation on both sides of the lining is one of the first essentials to its preservation; hence horizontal studding and the placing of linings directly against beams or sills should be avoided as well as the lining of stone walls with wood.

Silo linings.—In the majority of cases the best results have been associated with the lining consisting of two layers of boards with tar paper between them, but it does not appear essential that either should be matched; they should be of uniform thickness, however, and the narrower widths are best. On account of the conditions which work for and against the rotting of linings I believe a still more effective and durable lining may be secured by painting both layers of boards on one side only with hot coal tar boiled until it is not sticky when cold. The tarred sides should be placed face to face in the silo, tar paper between them, and I would urge the painting of the paper with cold coal tar after it is in place, but no faster than the inner lining is put on. * * *

The sills.—These should rest on a good stone wall, well bedded in mortar after having their under sides and inner edges painted with coal tar, as described for the lining, and they should be everywhere at least 6 inches above the bottom of the silo inside and 8 inches above the earth outside.

The comparative expense of different kinds of lining for round silos is estimated. The following comparative calculations of the cost of rectangular and round silos are given:

Rectangular silo, 180 tons.

14x24 inside, 30 feet deep.

Foundation, 13.44 perch, at $1.20	$16.13
Studding, 2x12, 28 ft., 4,704 ft., at $20	94.08
Sills, etc., 2x10, 26 ft., 206 ft., at $19	4.94
Sills, etc., 2x10, 16 ft., 426 ft., at $14	5.96
Rafters, etc., 2x4, 20 ft., 400 ft., at $16	6.40
Roof boards, fencing, 450 ft., at $15	6.79
Shingles, 5 M., at $3	15.00
Drop siding, 8 inch, 2,779 ft., at $16	44.46
Lining, sur. fencing, 4,256 ft., at $15	63.84
Tar paper, 426 lbs., at 2 c	8.52
Coal tar, 1 barrel	4.50
Painting, 60 c. per square	15.00
Nails and hinges	10.00
Cementing bottom	5.00
18 ¾-inch bolts, 18 inches long	2.70
Carpenter labor at $3 per M., and board	41.16
Total	344.44

Round silo, 180 tons.

20 feet inside diameter, 30 feet deep.

Foundation, 7.5 perch, at $1.20	$9.00
Studs, 2x4, 14 and 16 ft., 1,491 ft., at $14	20.93
Rafters, 2x4, 12 ft., 208 ft., at $14	2.91
Roof boards, fencing, 500 ft., at $15	7.50
Shingles, 6 M., at $3	18.00
Siding rabbeted, 2,660 ft., at $23	61.18
Lining, fencing, ripped, 2,800 ft., at $18	50.40
Tar paper, 740 lbs., at 2 c	14.80
Coal tar, 1 barrel	4.50
Hardware	6.00
Painting, 60 c. per square	13.20
Cementing bottom	5.00
Carpenter labor at $3 per M., and board	33.17
Total	246.59

Details of construction are illustrated by four figures. The following suggestions regarding the repair of silos are taken from the bulletin:

The matter of ventilation is the first point requiring attention. This can be secured in most of the silos which have carefully constructed dead-air spaces, by removing the upper board next to the plate or by sawing out sections between each pair of studding. These openings may be covered with netting.

Where paper has been placed against the side of the barn and strips of furring used to carry the lining, I believe the best way will be to remove the lining, take off the strips of furring, and apply sound lining directly to the paper, putting on new paper where the old is injured.

Where stone walls have been faced with wood and the lining is rotting, the wood should all be removed and the wall plastered so as to be a little more than flush with the lining above, and those silos which have walls which set back under the lining above should be faced out flush. A jog outward into the silo below is often admissible but the reverse never.

Where only small patches of lining are rotting it may be best to cut out the rotting wood and paint the edges well with carbolic acid or creosote oil to kill the germs. Then fit in a block and nail over it a piece of tin and paint this with a coat of hot, thick coal tar.

Where dirt has been banked against the lining it should be removed and the bottom lowered enough to let the boards become dry when the silage is removed.

Rotting silage should not be allowed to remain in the silo. When it must be left for a time, it should be thrown into the center away from the walls.

The cases of rotting against sills and beams are the most difficult to meet. It is, of course, important to prevent the rotting from extending to the sills, and in some of the cases this may be done by providing ventilation behind the lining and then removing the lower 2 feet of lining, facing each stud with a wedge-shaped strip about an inch thick at the bottom, letting it extend downward across the sill. Then, when the lining is restored and the wall below made flush with it, the ventilation will help to protect both sill and lining.

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF STATISTICS.

REPORT NO. 88 (NEW SERIES), SEPTEMBER, 1891 (pp. 441–518).—This includes a report on the condition of the cereals, potatoes, cotton, tobacco, sorghum, fruits, and the relative numbers and condition of fattening swine September 1; a brief history of the development of the Russian crop-reporting system, with a statement of wheat production in Russia; a review of the rye situation; a reference to the cause of the reduction of the price of cotton; a local record of prices 70 years ago; a statement concerning crop conditions in Indiana and Illinois; articles on the agriculture of Ecuador, South America, and on the People's Banks of Austria-Hungary; European crop report for September; notes on foreign agriculture; and rates of transportation companies.

Statistics of Russian wheat for 7 years.

Years.	Winter wheat.	Spring wheat.	Total.
	Bushels.	*Bushels.*	*Bushels.*
1883	54, 788, 053	172, 004, 515	226, 792, 568
1884	79, 861, 622	187, 581, 242	267, 442, 864
1885	77, 228, 474	100, 855, 926	178, 084, 400
1886	40, 267, 325	123, 187, 948	163, 455, 273
1887	98, 881, 512	179, 816, 405	278, 697, 917
1888	110, 690, 919	185, 011, 574	295, 711, 493
1889	41, 742, 626	136, 740, 826	178, 483, 452
Average	71, 924, 219	155, 028, 348	226, 952, 567

Statistics of Russian cereals and peas for 1890.

	Russia.		Poland.	
	Chetverts.	Bushels.	Chetverts.	Bushels.
Wheat (winter)	13, 248, 100	78, 905, 684	2, 078, 100	12, 377, 164
Wheat (spring)	22, 510, 900	134, 074, 920	44, 300	263, 851
Rye	113, 065, 700	673, 419, 309	7, 632, 400	45, 458, 574
Oats	90, 813, 900	540, 887, 588	6, 042, 000	35, 986, 152
Barley	27, 396, 400	163, 172, 958	2, 059, 100	12, 264, 000
Spelt	1, 853, 600	11, 040, 042		
Buckwheat	7, 760, 800	46, 223, 325	524, 300	3, 122, 731
Millet	9, 015, 600	53, 696, 914	178, 900	1, 065, 528
Maize	4, 068, 700	24, 233, 177		
Peas	2, 580, 500	15. 369, 458	886, 700	5, 281, 185

BUREAU OF ANIMAL INDUSTRY.

Cause and prevention of swine plague, T. Smith (pp. 166, plates 12).—This is the second special report on the investigations of infectious swine diseases conducted by the Bureau, the first being on hog cholera (see Experiment Station Record, vol. I, p. 103). The present volume contains the details of investigations which have led to the differentiation of swine plague as a disease distinct from hog cholera. After a short introduction the subject is treated under the following heads: Brief description of the methods employed in the investigations; brief summary of the earlier investigations of swine plague (1886–88) in Illinois, Iowa, Maryland, and the District of Columbia; investigations of 1889–90 in the District of Columbia and New Jersey; swine-plague bacteria, general characters, and resistance to destructive agents; pathogenic action of swine-plague bacteria—(1) effect on small animals, (2) the disease in swine as produced by the inoculation of cultures, (3) swine plague as observed in epizoötics, (4) disease of the digestive tract in swine plague; attenuated swine-plague bacteria in sporadic cases of pneumonia, in septic diseases of swine, and in the upper air passages of healthy swine and other domesticated animals; other investigations of swine plague in America and Europe; practical observations—(1) conditions which may favor or oppose outbreaks, (2) distribution and transmission of swine-plague bacteria, (3) relation of hog cholera to swine plague, (4) relation of swine plague to diseases of other domesticated animals, (5) measures to be taken in the prevention of swine plague; conclusions; appendix—the presence of septic bacteria probably identical with those of swine plague in the upper air passages of domestic animals other than swine, by V. A. Moore.

The general conclusions from the investigations reported are thus stated:

(1) There are two independent infectious diseases of swine, swine plague and hog cholera, each caused by an easily recognizable, specific disease germ.

(2) Swine plague (in those outbreaks which have come to our notice) is limited chiefly to the lungs in its destructive effect. The intestines may be and frequently are involved in the disease process. Hence it is an infectious pneumo-enteritis rather than an infectious pneumonia.

(3) There is considerable variation in the virulence or disease-producing power of swine-plague bacteria from different outbreaks. The greater the virulence, other things being equal, the severer and more extensive the epizoötic.

(4) The bacteria of *Schweineseuche* (German disease of swine) are identical with those of swine plague.

(5) In the upper air passages of a certain percentage of healthy swine, cattle, dogs, and cats, bacteria exist which belong to the species of swine-plague bacteria, and which as a rule possess a relatively feeble virulence. While it is probable that such bacteria may produce disease it may be regarded as pretty certain that it is largely aided by secondary causes producing unthriftiness, and is merely sporadic and not communicable.

(6) In many epizoötics of swine disease both hog cholera and swine-plague bacteria, as well as the respective lesions of these bacteria, coexist. Such mixed diseases are

due to the frequent presence of both bacteria in the surroundings of swine, probably a result of frequent introduction. Either disease may be primary, according to its relative virulence.

(7) It is highly probable that the many attenuated varieties of either disease germ can produce disease only when assisted by the other germ or by the unsanitary, unphysiological methods of rearing swine, by which the latter are reduced in vitality and made more susceptible.

(8) It is pretty well established that there are a number of infectious diseases affecting cattle, buffaloes, deer, fowls, and smaller animals, the bacteria of which are closely related if not identical with those of swine plague. These plagues appear in various parts of the globe sporadically. (*Wild-und Rinderseuche, barbone bufalino,* fowl cholera, rabbit septicæmia.) Their tendency to spread from one species to another, from cattle to swine for instance, probably depends on the degree of virulence of the bacteria as well as the opportunities afforded for such transmission.

(9) Swine-plague bacteria are very probably introduced into a herd only in the bodies of animals, since they are speedily destroyed in soil and water by natural agencies. Virulent varieties are perhaps always derived from preëxisting disease. Attenuated varieties may be introduced by healthy animals. Since these may under special conditions give rise to disease, efforts to prevent and suppress infection must take into account the physical condition of the exposed animals.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

Reports of the Prussian experiment stations for 1890.—The following brief abstracts of the reports of the experiment stations in the Kingdom of Prussia are taken from the reports of the individual stations to the Prussian Minister of Agriculture, Domains, and Forests, as published in the *Landwirtschaftliche Jahrbücher, 20 (1891), sup. 1, pp. 6–74.* The original reports contain very few details, and in some cases consist merely of lists of the investigations carried on, which are of interest chiefly as indicating the lines of work pursued.

Bonn; Dr. A. Stutzer, director.—The analytical and seed-control work of this station included tests of 3,146 samples. The following scientific investigations were also carried on: (1) Studies of the rate of solubility of the digestible albuminoids of different foods and feeding stuffs in dilute hydrochloric acid and pepsin hydrochloric acid. The object was to determine whether when the mechanical hindrances to the action of the solvents were eliminated as far as possible, the digestible portion of albuminoids from different feeding stuffs would be dissolved with the same degree of rapidity in different cases. Considerable differences were noticed in this respect. For instance, of 100 parts of digestible albuminoids from cotton-seed meal and from peanut meal the following percentages were dissolved:

	Cotton-seed meal.	Peanut meal.
	Per cent.	*Per cent.*
By cold water	9	60
By pepsin solution acting for one half hour the solubility was increased to	62	98

The conclusion is that the protein of peanut meal is more easily digestible than that of cotton-seed meal. (2) On the changes in the digestibility of the albuminoids of foods and feeding stuffs caused by heating (see Experiment Station Record, vol. II, p. 527). (3) On the influence of common salt, of different organic acids, and of saccharin on the digestibility of albuminoids (see Experiment Station Record, vol. II, p. 525). (4) On the influence of fats and oils contained naturally in feeding stuffs on the digestibility of the albuminoid materials (see Experiment Station Record, vol. II, p. 529). (5) Field experiments with different varieties of oats, wheat, and rye made under the direction of the German Agricultural Society. (6) Experiments with a method for

determining the amount of fusel oil in spirits. It was found to be possible with the improved method to detect the presence of 0.01 per cent of fusel oil in spirits.

The author refers to the practical tests at the Göttingen Station (see p. 259) of the method of artificial digestion worked out under his direction, which throw new light on the determination of the digestibility of protein by artificial means.

Bremen; Prof. M. Fleischer, director.—In 1890, besides numerous analyses of fertilizers and feeding stuffs, the work included investigations of different moor soils, field experiments on moors, and vegetation experiments in pots, none of which are described.

Breslau; (1) *Experiment and Control Station; Prof. F. Holdefleiss, director.*—The analyses and examinations by this station included 3,854 samples of materials, among which were a large number of feeding stuffs, food materials, fertilizing materials, substances used for technical purposes, and soils. The feeding stuffs were as a rule not only analyzed but also examined microscopically with reference to purity and to condition (spoiled or not). Here, as at Posen (see below), rye bran was found to be very extensively adulterated not only with weeds, including some poisonous varieties, but also with all sorts of spores from rusts and blights of the grain, in some cases to such an extent as to render the bran unfit for food. Of the fertilizing materials bone meal and Thomas slag meal were more often found to be adulterated than any others. Ground bone was adulterated by replacing the gelatinous materials which had been removed by steaming, not only with horn, hair, and the like, but also with castor pomace.

Aside from the analytical work the following investigations have been carried on during the year: (1) Studies of bone and bone meal with a view to devising a means of judging of the various preparations of bone which occur in the market. The results of this work have been published by Dr. Holdefleiss in a pamphlet entitled *Das Knochenmehl, seine Beurtheilung und Verwendung;* (2) field experiments with potatoes and with different varieties of grain in different parts of the Province; (3) a critical study of the process employed by Chevalier Seeling von Saulenfels for removing the bitter taste of lupine.

(2) *The Station for Agricultural Botany and Seed Control; Dr. E. Eidam, director.*—During 1890 this station tested 1,905 samples of seeds and made various botanical examinations.

(3) *Institute for Animal Chemistry; Prof. H. Weiske, director.*—This is connected with the university at Breslau. In the experimental work the director is assisted by Dr. S. Gabriel. The work of the year included investigations in physiological chemistry and in animal nutrition, especially with reference to the digestibility of feeding stuffs.

Dahme; Prof. R. Ulbricht, director.—Besides chemical analyses and meteorological observations, the activity of this station has been along the following lines: (1) Pot experiments on the relative agricultural

value of phosphoric acid in different compounds and in different raw phosphates. The results of growing maize in unlimed moor soil, to which was added in separate instances 60, 120, and 240 kg. of phosphoric acid in the form of superphosphate, South Carolina phosphate, Lahn phosphorite, Norwegian apatite, and Kladno phosphate meal, indicated that the acid of the moor rendered the crude phosphorite valuable to the plants in a high degree. The results with 240 kg. of phosphoric acid in the form of Lahn phosphorite and 120 pounds in the form of South Carolina phosphate were practically the same. Similar experiments were made with barley grown in soil which had received a dressing of lime. These later experiments showed that the action of the raw phosphorite was less favorable in the limed than in the unlimed soil. (2) Experiments as to the fixation of free atmospheric nitrogen by papilionaceous plants. The results indicated very strongly that the vetches are to be classed with those plants capable of assimilating the nitrogen of the air. The experiments are to be continued. (3) Field experiments with the more important papilionaceous plants, to determine the amount of atmospheric nitrogen which the plant accumulates, and which in green manuring would be added to the soil. Owing to the large number of analyses necessary the results of these experiments have not yet been ascertained. (4) Field tests of *Vicia sepium*, *V. dumetorum*, etc. (5) Determination of the amount of mustard oil yielded by the seeds of cruciferæ and by rape cake. Twenty-eight samples of rape cake were tested. In most cases considerable amounts of this oil, up to 0.69 per cent, were found. (6) Investigations of the methods of determining phosphoric acid. The percentage of phosphoric acid in numerous samples of Thomas phosphate meal ranged from 15 to 23; two samples were found to contain Redonda phosphate.

The experiments on the above subjects will be continued in 1891, and in addition the following work is proposed: (1) Experiments to compare the agricultural value of the nitrogen in the forms of saltpeter and ammonium sulphate; (2) feeding experiments with pigs; (3) investigations as to the occurrence of gypsum, lime, and marls in the Province of Brandenburg, so far as they are of agricultural interest; (4) field experiments with the old and new varieties of potatoes, and (5) field experiments with maize.

Danzig; Dr. Güntz, chemical director.—The work of this station has consisted largely of analyses of various materials and examinations of seeds. In a large number of analyses of Thomas slag the highest percentage of phosphoric acid found was 21.69, the lowest 12.21; and 53.6 per cent of the determinations showed 18 per cent or over of phosphoric acid. In seven cases Redonda phosphate was found to be mixed with the slag meal.

Eldena; A. von Homeyer, director.—This is a control station, and its work during the year was confined to the fertilizer, feeding stuff, and seed controls, and the analysis of materials of interest to agriculture.

Geisenheim; Prof. H. Müller, director.—This station has made chemical studies on the composition of fruit wines, on the sugars in sweet fruits, on the sulphuric, sulphurous, and carbonic acids in wine, and on other matters relating to wine manufacture.

Göttingen; (1) *Agricultural Experiment Station; Prof. W. Henneberg,* director.*—The work of the year 1890 was in part a study of the constituents of feeding stuffs and in part studies, with the aid of the respiration apparatus, of the processes of the formation of fat and lean meat. The first experiment was with regard to the much discussed problem of the artificial digestion of protein, and was designed to settle the question as to the accuracy of the coefficients of digestibility of the protein in feeding stuffs, as determined by experiments in artificial digestion. The indications from these experiments were that the artificial digestion of protein is identical with the natural digestion, but since animals excrete considerable amounts of nitrogen-containing metabolic products, the natural digestion seems to give lower coefficients of digestibility than the artificial. If, then, a method can be devised for estimating the amount of these metabolic products the results of artificial digestion may be corrected for the natural digestion; and if the excretion of metabolic products is found to follow general rules, then it will become possible to calculate from the results obtained by artificial digestion the true coefficient of digestibility for the protein corresponding with the coefficient obtained in experiments on animals. On the basis of investigations commenced in Weende and continued for the past 3 years at Göttingen, a method for accurately determining these metabolic products has been perfected and the laws governing the excretion of these products have been worked out. According to the results obtained, for every 100 grams of dry matter digested 0.4 gram of nitrogen in the form of metabolic products is excreted, which at present is reckoned as undigested protein. Repeated experiments have shown the method to be reliable, but have indicated that the excretion of metabolic products is dependent upon two things, (1) the amount of dry matter digested, and (2) the amount of undigested dry matter in the food. The proportion of 0.4 part of metabolic nitrogen to 100 parts of digested dry matter is therefore not infallible, but applies in general where moderately concentrated feeding stuffs are used. The coefficients obtained by experiments in artificial digestion must therefore be recalculated to obtain results applying to animals. Thus the difference between the percentage (63 per cent) of the protein in dried diffusion chips said to be actually digested by ruminants and the coefficient (87 per cent) indicated by artificial digestion, is said to be fully explained by the metabolic products.

The results of an experiment on the digestibility of oat straw showed that the digestibility of the straw was very considerably increased by treatment with a solution of sodium hydrate, for while 47 per cent

* Died November 22, 1890; succeeded by Prof. F. Lehmann.

of the organic matter in the untreated straw was digested by animals, from 70.7 to 71.9 per cent was digested from treated straw. The experiments with regard to the nutritive value of cellulose, an account of which was given in Experiment Station Record, vol. II, p. 613, are referred to.

(2) *Control Station; Dr. Th. Pfeiffer, director.*—This station reports analyses and tests of 687 samples of fertilizing materials, feeding stuffs, foods, seeds, etc. Microscopic examinations have often been of service in detecting the adulteration of feeding stuffs. The addition to rice meal of so-called protein meal, a by-product from the manufacture of starch, was noticed to a considerable extent.

Halle; (1) *Agricultural Institute of University; Prof. Julius Kühn, director.*—Field experiments were made on the effect of the continued use of each of several methods of culture and of different fertilizing materials; on the means of combating the beet nematodes; and on the influence of root tubercles in the assimilation of nitrogen by leguminous plants. Tests of varieties of plants, experiments on the prevention of the loss of nitrogen from manures, and studies on the improvement of exact methods of field experimentation are also reported. Feeding experiments with milch cows are to be undertaken during 1891.

(2) *Agricultural-Chemical Experiment Station; Prof. M. Maercker, director.*—An abstract of the report of this station, which is under the auspices of the Central Agricultural Society of the Prussian Province of Saxony, was given in Experiment Station Record, vol. II, p. 759.

Hildesheim; Dr. Karl Müller, director.—The work of this station included critical examinations of 2,570 samples of artificial fertilizers, feeding stuffs, seeds, etc.

Insterburg; Dr. W. Hoffmeister, director.—Besides the detective and general analytical work of this station, scientific investigations have been carried on with a view to devising a method for the quantitative separation of the different forms of wood gum, cellulose, and incrusting substances, and studies have been made of the sugars formed from the different wood gums.

Kiel; (1) *Agricultural Experiment Station; Prof. A. Emmerling, director of the agricultural-chemical division, and Dr. M. Schrodt, director of the dairy division.*—The total number of samples examined in the chemical laboratory was 2,111, of which 1,176 were in connection with the fertilizer control and 347 in connection with the control of feeding stuffs. Experiments were also made on the determination of the fat in linseed cake, using an apparatus devised at the station for drying in a stream of illuminating gas; on the estimation of the percentage of horn in bone meal; on the changes in composition and the percentage of fat of freshly mown grasses; and a large number of grasses from the Province of Schleswig-Holstein were analyzed. The chemical division proposes in 1891 to carry on studies as follows: (1) Thorough microscopic and chemical investigations of the palm nut and the feeding

stuffs prepared from it; (2) on the estimation of fat in linseed cake; (3) on the behavior of fat toward animal charcoal.

The dairy division has made analytical studies of the morning's and evening's milk of ten cows and of the milk of different breeds; examinations of butter fat and of the percentage of water in Schleswig-Holstein butter, and experiments with the Danish hand-centrifuge. Of the 158 samples of milk sent to the station for analysis 18 were found to have been watered and 21 to have been partially skimmed or diluted with skim milk. Twenty-five per cent of the samples, therefore, were found to have been tampered with, and 11 others were suspected. It is proposed during the present year to make experiments on the determination of solids in milk; on the value of fluorine salts, especially sodium fluoride, as a milk and butter preservative; studies of the albuminoid materials in "stringy" milk; and feeding experiments with milch cows.

Among the investigations of the bacteriological division were studies of the use of pure cultures of bacteria in ripening cream. This use of pure cultures is analogous to their use in the manufacture of spirits, where their introduction has been attended with marked success. A preliminary experiment, made in February, 1890, was followed by encouraging results. More extensive experiments were then made to determine whether the project was practicable on a large scale and whether the pure cultures could be retained practically pure for any considerable length of time. The material for inoculation of the fresh cream was taken each time from the buttermilk of the previous churning, and it was found that in this way relatively pure cultures could be retained for about 14 days. In later experiments in a large creamery it was recommended to transplant the bacteria by using a small amount of the ripened cream, and this was found to work successfully. As to the possibility of eliminating numerous undesirable qualities of butter by the use of pure cultures of lactic-acid bacteria, tests which were made showed at once a favorable change in the quality of the butter, and indicated that these faults could be prevented by the use of pure cultures. The station has also distributed pure cultures, and in each case has requested that a report be made of the results of their use. In cases where the butter was oily, possessed a musty or an oily flavor ("beet taste"), or was generally poor, the use of these cultures has been attended by a marked improvement in aroma and quality of the butter. Several critical examinations of butter which possessed undesirable qualities, such as a decidedly oily consistence, a strong, acid flavor, and other disagreeable flavors, showed the presence of large quantities of yeasts and molds of various forms in every instance.

Studies of the causes of the formation of cavities in cheese indicated that this was due to bacteria which are capable of decomposing the milk sugar (and perhaps also the albuminoids) and thus evolving gases. The size of the cavities and the character of the gases depend upon

the form of bacteria present. An organism which caused a bitter taste in milk was isolated and studied. A chemical examination indicated that the bitter taste was not due to butyric acid, as has been stated, and it is suggested that it may be due rather to some intermediate products in the changes of the albuminoids.

The experiments on cheese, and the bacteriological-chemical investigations on the souring of cream and of slimy and stringy milk are to be continued in 1891, and new experiments are to be commenced on the process of ripening cheese.

(2) *Agricultural Institute of University; Dr. H. Rodewald, director.*—This seed control station examined 1,490 samples of seeds with reference to purity, germination, etc. Experiments are planned for 1891 on the effect of different conditions of humidity of the air on irregularities and difficulties in the germination of seeds.

Königsberg; (1) *Agricultural Experiment Station; Dr. G. Klien, chemical director.*—Examinations and analyses were made of 1,981 samples of fertilizing materials, feeding stuffs, seeds, dairy products, etc., and meteorological observations were taken. In 1889 Dr. Klien* made experiments which he believed pointed toward a direct transmission of the fat of food into the milk. The experiments were with goats. The food consisted of bran, to which an increasing amount of palm nut oil was added up to the limit to which the animal would consume it. The saponification equivalent of the milk fat increased from 233 to 241; the equivalent for the palm nut oil added to the food was 247. After feeding a normal ration for some time another trial was made in a similar manner, except that rape seed oil, having a saponification equivalent of 177, was added to the bran in place of palm nut oil. The saponification of the milk fat fell during this feeding to 216. The report for 1890 states that experiments on this subject have been continued, and that the results agree in general with those previously obtained.

Fish were also made the subject of feeding experiments to determine whether fish of prey could become accustomed to vegetable food in place of animal food, and if so to observe their condition on an exclusively vegetable diet. Repeated attempts to compel them to accept vegetable food were unsuccessful, even after a long starvation period.

Experiments were commenced in 1890 on the effect of different amounts of gypsum on the development of oat and barley plants. In these experiments the condition of the plants in soil poor in gypsum was compared with that of plants in soil mixtures containing 10, 25, and 50 per cent of gypsum, respectively, and in gypsum without soil, the other conditions as to fertilizers, etc., being the same in all cases. Measurements of the leaves showed, as had been previously found with clover, that the gypsum was favorable to a luxuriant leaf growth, the leaves of plants grown in the soils containing large amounts of gypsum being longer and broader than the others.

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*Jahresber. ü. Agr. Chem., 1890, p. 647.

The plan of 1891 includes studies of the roots of leguminous plants, culture experiments with six varieties of oats on twelve different farms, and a comparison of the agricultural value of the phosphoric acid in bone meal and in Thomas slag meal, for potatoes and oats.

(2) *Dairy Laboratory of the Agricultural Institute of the University; Prof. W. Fleischmann, director.*—At present the laboratory is mainly used for purposes of instruction. No report of investigations is given.

Marburg; Prof. Th. Dietrich, director.—The activity of the station has been confined very largely to the making of analyses, examinations of various materials, and tests of seeds, 3,910 samples of all kinds having been examined.

Münster; Prof. J. König, director.—The work at this station has been largely analytical, the number of samples of feeding stuffs, fertilizers, soils, seeds, etc., examined during the year being 3,748. The Alsatian and French iron ores are said to contain smaller amounts of phosphoric acid than the German, so that Thomas slag derived from these ores contains a lower percentage of phosphoric acid than the normal, that is, 17 per cent. These poorer grades were found in the market to a considerable extent at times. Phosphate meal with as low as 11 to 12 per cent of phosphoric acid is mentioned. The adulteration of Thomas slag was found to be very common, the adulterants noticed being Redonda phosphate meal, and a precipitate from phosphates of iron and alumina; other mineral phosphates, as Atlas phosphate, have also been used for adulteration. Redonda phosphate is said to consist largely of phosphate of alumina, and Atlas phosphate of phosphate of iron, the phosphoric acid being in both cases almost entirely insoluble in acetic acid, while about half the phosphoric acid of a genuine Thomas slag should be soluble in acetic acid. But it was not found possible to detect adulteration with these phosphates by the amount of phosphates of iron and alumina present, since Thomas slag contains normally more or less of these compounds.

Poppelsdorf; Prof. U. Kreusler, director.—The work of 1890 included the following subjects: (1) Investigations of certain nitrogen-free constituents of vegetable coloring matters; (2) the respiration and assimilation of plants; (3) the processes of decomposition accompanying fermentation, putrefaction, and decay, with special reference to nitrification and the gains or losses of nitrogen; (4) the value of grains grown under varying conditions, especially of wheat with reference to baking qualities; (5) the value of brushwood (*Holzreisig*) for feeding purposes; and (6) meteorological observations,

Posen; Dr. G. Loges, chemical director.—This station reports having made examinations of 1,624 samples of various materials, including about 800 of fertilizers, nearly 600 of feeding stuffs, 100 of seeds, etc. Numerous cases were noticed of adulteration of Thomas slag meal with Redonda phosphate, and less seldom with phosphorite. Of the 596 samples of feeding stuffs examined, 497 were tested as to purity and

quality. A surprising condition was noticed with regard to the rye and wheat bran offered for sale in the Province of Posen. Of the 174 samples of rye bran examined, only 21.6 per cent were found to be pure, that is free from adulteration with other materials, and even these were not always in a good and fresh condition; 68.2 per cent had received additions of rye chaff, 8.5 per cent sand or dirt (up to 18 per cent), and 18.2 per cent so much ergot that the bran was considered unsafe for feeding. Another adulterant used for rye bran was finely ground oat chaff, as large amounts of this material as 40 per cent being found in some cases. The oat chaff is said to contain only 1.3 per cent of protein and 0.3 per cent of fat. It was also sold alone under the name of "oat bran" at the price of other brans. The 58 samples of wheat bran examined were found to be somewhat better, 67.8 per cent of these being unadulterated; 28.5 per cent contained rye chaff; and 3.7 per cent admixtures of sand. It was observed in general that the coarser brans produced in the roller process were almost entirely free from adulteration, which would be more perceptible than in the case of finer material. The station has worked out a method for detecting the adulteration of Thomas meal, and separating the adulterants quantitatively, which is not described in detail in the report;* and has proved the reliability of a method worked out elsewhere for the determination of the free fatty acids in feeding stuffs.

The work outlined for the present year includes studies of feeding stuffs in connection with the investigations undertaken by the Association of German Stations, studies of the properties of hot and cold-pressed rape cake, soil investigations, and field experiments in coöperation with an agricultural society in the Province.

Proskau; Dr. P. Sorauer, director.—Several new investigations have been made during the year by Dr. Sorauer on plant diseases and plant physiology. The report enumerates the following subjects: (1) The difference in the behavior of the wounds of fruit trees pruned at different seasons of the year; (2) the symptomatic significance of intumescence; (3) studies of the canker occurring on the genus *Rubus*; (4) investigations of the parasitic growth causing a blight on cabbages and other *Cruciferæ*; and (5) certain diseases of the grapevine. In 1891 studies of the first two subjects are to be continued, and new ones undertaken on (1) the formation of gum by injured (diseased) plants as a result of the action of bacteria; (2) *Peronospora viticola* and the means of combating it; (3) trials of copper preparations for parasitic diseases; (4) the rusts of fruit trees; and (5) the effect of noxious gases and fumes on fruit trees.

Regenwalde; Prof. H. Birner, director.—In 1890 this station made examinations of 1,598 samples of seeds, fertilizers, feeding stuffs, oils, etc. In addition to this work three field experiments are reported as follows: (1) Experiments with six different varieties of potatoes to study the effect upon the yield and the starch content of tubers, of nitrate

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* Deut. landw. Presse, 1890, p. 525.

of soda with and without superphosphate, and of barnyard manure. The beneficial effects of nitrate of soda were apparent with all the varieties. (2) Experiments as to the yield of yellow and blue lupine and serradella, both grass and stubble, under the most advantageous conditions, the results of which are not yet reported. (3) A comparison of sowing lupine broadcast and in drills. This experiment was made on eight plats, each 25 square meters in area, on four of which the seed was broadcasted at the rate of 175 pounds per acre, and on the other four drilled at the rate of 80 pounds per acre. The results showed that at the time of blooming 85.2 per cent of the seeds capable of germinating had produced plants where the seed was broadcasted and 92.4 per cent where the seed was drilled. In the laboratory studies were made (1) on the effects of adding kainit and carnallite to lime soils; (2) on the relation between the free fatty acids and the spoiling of feeding stuffs; (3) on the changes in finely ground feeding stuffs by long exposure to the air; (4) on the culture of the oil turnip and its value as a fodder plant; and (5) on the culture and composition of *Stachys tuberifera*. The results of these experiments have not yet been published. The investigations upon the changes in feeding stuffs showed, among other things, that by lying exposed to the air for 6 months linseed meal lost not less than 73 per cent of its fat.

Wiesbaden; Prof. H. Fresenius, director.—Five hundred and ninety-one analyses were made during the year, most of which were in connection with the control of fertilizers and feeding stuffs.

To the above reports of Prussian stations the reports for 1890 of the station at Rostock and the seed-testing station at Hohenheim are appended.

Rostock; Prof. R. Heinrich, director.—The number of analyses of various materials and tests of seeds made during 1890 was 4,877. Of these there were 730 samples of fertilizing materials, 45 per cent of which were Thomas slag. Adulterations of the latter with Redonda phosphate were noticed in 23 cases. Three separate cargoes of Thomas slag, imported direct from England, were each found by the author to contain Redonda phosphate. Of feeding stuffs 704 samples were analyzed, the larger part being of peanut and cotton-seed feeding stuffs.

Field experiments were made to determine the best time for applying nitrate of soda to winter and summer grains, the results showing that in general the nitrate should be applied just as the plant begins its vigorous growth but before it has commenced to shoot upwards. A comparison of the effects of different nitrogenous fertilizers for oats showed for the first year the following relative action as based on the best result at 100: Ammonium sulphate 100, ground meat 72, ground bone 65, ground leather 59, dried blood 58, and ground horn 33. The plats receiving nitrate of soda met with an accident, but the results up to that time appeared to be similar to those with ammonium sulphate. Feeding experiments were made with cows as to the effect of food on

the fat content of the milk, the results of which indicated an increase in both per cent and total amount of fat in the milk when cocoanut cake was fed as compared with peanut cake (see Experiment Station Record, vol. III, p. 67), and the experiments of the previous year to compare the effects of sesame cake and peanut cake for fattening young lambs, were concluded. No striking differences were observed between these two materials, but each year the results were slightly in favor of the sesame cake.

The station has also superintended during the past year a series of coöperative field experiments on forty different farms to study the requirements of the soils. The results were controlled at the station by means of pot experiments. In these trials large pots were filled with soil from each farm and the same kinds and amounts of manure were used and the same kinds of plants were grown as on the larger fields. These pot experiments, showing the effects of different fertilizers on the different soils, are said to have been of much interest and served as an object lesson to large numbers of farmers who visited the station.

Hohenheim; Seed-Testing Station; Prof. O. Kirchner, director.—During the year ending October 1, 1890, this station tested 836 samples, representing over 286,000 pounds of seed, of which 599 samples were of clovers, the red clover predominating. Plat experiments with red clover, which have been in progress since 1885, to observe the relative yield of clover from different countries, have indicated that in that climate varieties from central Europe (those from Germany, Austria, Styria, Bohemia, Hungary, Poland, and England) differ very little in desirability, provided they have not come originally from America or southern Europe (Italy, southern France, southern Hungary, etc.).

In similar plat experiments during 2 years with lucern from Italy, Hungary, Provence, Würtemberg, and America the largest total yields of green fodder from successive cuttings was with Italian lucern and the smallest from American. In 1889 the yield of the American was 54.33 per cent and in 1890, 47.55 per cent as large as the yield of the Italian. Where American seed was used about half the plants died out the first season. The author believes it to be undesirable that American seed be placed on their market, and warns farmers against sowing it. He states that equally unfavorable results have been obtained with American lucern seed in Switzerland and France.

Investigations as to the changes in feeding stuffs by souring in the silo, O. Kellner, Y. Kozai, and Y. Mori, reported by O. Kellner (*Landw. Vers. Stat., 39, pp. 105–114*).—Earlier investigations by the author and J. Sawano seemed to show that the decomposition of the nitrogenous constituents of feeding stuffs in the process of ensiling was, in some cases at least, accompanied by the formation of ammonia, which was partially or wholly driven off during the drying of the material for analysis. Experiments with white clover as to

the extent of this loss and its proportion to the total nitrogen lost, indicated that when the ammonia which escaped during the drying of the silage was taken into account the amount of nitrogen in the sour silage was approximately equal to that in the original material before ensiling; or in other words that in the fermentation of feeding stuffs containing much water under exclusion of air no perceptible loss of nitrogen occurs.

The present series of experiments were carried on with (1) *Imperata arundinacea*, (2) Italian rye grass, (3) buckwheat (upper part, in milk stage), (4) mulberry leaves, and (5) turnip leaves (Japanese Daikon), each of which was treated as follows: About 5 kg. of the fresh material, from which the coarser stems, etc., had been removed, was cut finely and mixed, and while one portion was dried and analyzed at once another portion was sealed air-tight in a large glass bottle and buried about 1 meter deep in the ground. From 7 to 7.5 months later the samples were taken out and weighed. They were all found to be well preserved and entirely free from mold. The percentage of acid (calculated for lactic acid) ranged from 1.25 (mulberry leaves) to 28.16 per cent (turnip leaves) in the dry matter. The nitrogen was determined directly, and after previous drying, in samples of the silage from each material. None of the original materials except the turnip leaves contained more than a trace of nitric acid; the latter contained 0.795 per cent of nitric acid in the dried leaves. A determination of the nitric acid in the silage from turnip leaves indicated only a trace. The nitric acid had therefore almost entirely disappeared during the souring process—a result which agrees with previous observations by the author on beet leaves.*

The results of the analyses of the different samples of silage are in direct accord with the results of the experiments with white clover, and lead the author to the following conclusions:

(1) The chemical processes during the souring of feeding stuffs under exclusion of air cause no perceptible loss of nitrogen as long as the material used is free from appreciable amounts of nitric acid.

(2) In preparing the silage for analysis by drying, ammonia is generated through dissociation of organic ammonia compounds. The loss by this means in these experiments varied from 3.2 (*Imperata*) to 23.3 per cent (buckwheat) of the total nitrogen in the original material.

Determinations were also made of the digestibility of the protein in each of the materials before and after ensiling, as indicated by Stutzer's modified method of artificial digestion. The tests of the silage included tests of dried silage and of that from which the acid had been extracted by digesting with absolute alcohol. It was found that in general the process of ensiling had not rendered the protein less soluble in the digestive solutions, and in some cases in which the original material contained much cellulose the solubility of the protein was even higher in the silage than in the original material.

* Landw. Vers. Stat., 26, p. 451.

To observe the effect which ensiling had on the digestibility of the albuminoids, the non-albuminoid nitrogen was determined in the fresh and in the ensiled materials. In every case except that of *Imperata* the percentage of the non-albuminoids in the total protein was much larger in the ensiled than in the fresh material, *i. e.* the decomposition of the albuminoid materials during ensiling was very considerable in the case of the feeding stuffs very much richer in nitrogen, but in the case of *Imperata* (1.54 per cent nitrogen) there was comparatively little change. Assuming the non-albuminoid nitrogen to be entirely digestible, it was found on calculation that the digestibility of the albuminoids had considerably decreased in ensiling wherever any considerable decomposition of the albuminoids had taken place (all except *Imperata*). It would seem that the more soluble and digestible portions of the albuminoids are attacked during the fermentation, so that the albuminoids in the silage possess a lower coefficient of digestibility.

The loss of valuable ingredients of hay by exposure to rain, A. Emmerling (*Landw. Wochenbl. f. Schleswig-Holstein, 1891, pp. 569–571*).—From unpublished experiments made at the experiment station at Kiel in 1883 and 1884, the author was led to believe that the loss of valuable ingredients of hay by exposure to rain was dependent upon the number of rainy days and the amount of rainfall; but similar experiments in 1891 did not support this view, the amount of loss being proportionally much in excess of that of 1883 and 1884. Since the average temperature of the air in 1891 was 68° F. as compared with 62° and 60° in 1883 and 1884, respectively, he reasons that the temperature of the air is also an important factor. The increased temperature would aid the solution of the ingredients in water as well as the fermentation. Grass which during the past season was exposed in cocks and in swaths for 18 days, on 9 of which rain fell, sustained the following losses in percentages of the original amount of ingredients in the hay dried without wetting:

Percentage of ingredients in hay lost by exposure to rain.

	In cocks.	In swaths.
	Per cent.	*Per cent.*
Loss of total dry matter	18.3	29.4
Loss of crude fat	31.0	41.0
Loss of crude protein	29.0	24.8
Loss of digestible protein	19.8	38.8
Loss of non albuminoid protein (amides)	9.6	12.2

The loss in cocks and in swaths was therefore approximately as 62 : 100. This agrees very nearly with the relative losses in 1884, where the loss in cocks was about two thirds of that in swaths.

Coöperative experiments with cereals under the auspices of the German Agricultural Society (*Sächs. landw. Zeitsch., 1891, pp. 321–326*).—At a recent meeting of the German Agricultural Society

Professor Liebscher of Göttingen presented the report of the coöperative field experiments with cereals carried out in different parts of Germany in 1890, under the auspices of the Society. Of 124 experiments made, 30 were with wheat, 32 with rye, and 62 with oats. Several of the experiment stations participated in these experiments.

The results, aside from those relating to the tests of varieties, were in brief as follows: (1) The weight of kernel is a characteristic for the variety, and all previous observations have failed to show any change in this weight from continued culture. (2) The percentage of chaff or husk in the total weight of the kernel is also a characteristic for the variety, but no very considerable differences have been noticed between the different varieties tested. (3) The proportion of grain to straw, on the contrary, is relatively little affected by the variety. (4) The protein content of oats is practically independent of the variety. (5) The protein content of oat kernels is influenced in an exceptionally high degree by the kind and condition of the soil; and soil and climate also affect the proportion of grain to straw. The protein content was found to follow the yield, being the largest on a rich soil where the yield was largest. Thus it was found that on an average 75 pounds of grain grown on a loam soil contained as much protein as 100 pounds of grain grown on a sandy soil. The proportion of kernels in the total yield was also found to be largest in crops grown on heavy soils, which, the author says, is contrary to the general belief. According to this, therefore, light soils not only give smaller total yields of oats, but a larger proportion of straw to kernels, which also contain relatively less protein.

EXPERIMENT STATION NOTES.

ALABAMA STATIONS.—D. Gillis, M. S., has been appointed director of the Southeast Alabama Station vice T. M. Watlington, B. S., resigned. R. E. Binford, M. A., has become director of the North Alabama Station vice C. L. Newman, B. S.

COLORADO COLLEGE AND STATION.—A two-story stone and brick building, to cost $9,000, is being erected for the use of the station as well as of the college. A forcing house to be used for experiments in horticulture is also being built, together with a residence for the professor in charge of the farm. Exhibits have been made at several State and county fairs in Colorado of live stock, grain, and other agricultural products from the station and its substations.

CONNECTICUT STORRS SCHOOL.—A. B. Peebles, B. S., formerly connected with the Michigan College and Station, has been appointed professor in chemistry at the Storrs Agricultural School vice J. R. Hutton, B. S., resigned.

IOWA WEATHER AND CROP SERVICE REPORT FOR 1890.—This is the first annual report under the State law, approved April 25, 1890, and includes historical data regarding meteorological observations and crop statistics in Iowa; a sketch of the physical geography of Iowa, by R. E. Call; an article on climatology of Iowa, which contains a number of tabulated summaries of meteorological observations covering a number of years; and notes on the weather and summaries of meteorological observations in 1890, at different stations in the State.

KENTUCKY COLLEGE AND STATION.—C. M. Mathews has been elected professor of horticulture and botany in the college and horticulturist to the station.

NEW YORK CORNELL STATION.—H. Snyder, B. S., assistant in chemistry, has accepted the position of chemist to the Minnesota Station. L. C. Corbett, B. S., has been appointed assistant in horticulture vice E. G. Lodemann, B. S., who has been made an instructor in the Cornell University.

OHIO STATION.—The people of Wayne County having at a special election ratified the proposal of the county commissioners to donate $85,000 for the purchase of land for the station, the board of control will select the farm, and after the erection of suitable buildings the station will be moved.

UTAH STATION.—In a trial in which one lot of horses was watered before feeding and another lot after feeding, the results favored the former practice.

QUEENSLAND.—Bulletin No. 10, August, 1891, of the Department of Agriculture, Brisbane, contains a report of agricultural conferences held at Maryborough, Rockhampton, and Bundaberg. The topics presented in papers and addresses were, Wheat and its Cultivation, R. Adams; Improvement of Seed, D. Clarke; Dairying, B. Jones; Dairying and Dairy Cattle, Professor Shelton; Some Reasons for the Non-Keeping Qualities of Butter and Cheese, P. McLean; The Orange Tree and its Profitable Culture, P. Biddles; Tobacco Growing, S. Lamb; Farming for Profit, Professor Shelton; Tobacco Growing, A. Jones; Fruit Culture, J. S. Edgar; Canning and Fruit Preserving, Professor Shelton; Silos and Silage, R. S. Archer; Grazing Farms for Profit, Mr. Beak; Insect Pests, Professor Shelton; How to Improve the Breed of Horses, J. M. Murray; Durham Cattle, Mr. Peberdy; Mixed Husbandry, Mr. O'Shanesy; Maize, V. Murray; Cultivation and Tillage, Professor Shelton; Flowers, Miss E. M. Young; Fruit and Fruit Growing, Mrs. Maunsell; Cultivation of Cane and Manufacture of

Sugar, A. Gibson; Vine Culture, W. Melville; Bee Culture, G. Kendall; Potato Culture, B. Workman; The Farm Home, P. McLean.

GERMANY.—Professor Moritz Fleischer, for many years director of the Moor Experiment Station at Bremen, has been appointed professor of chemistry in the agricultural high school at Berlin as successor to Professor Landolt, and will enter upon his duties this fall. He will retain the general direction of the Bremen Station, but the work carried on will be under the immediate supervision of Dr. H. Tacke, formerly first assistant.

Professor Fleischer has resigned the position of editor in chief of Biedermann's *Central-Blatt für Agrikulturchemie,* which he has occupied for 11 years, and will be succeeded by Dr. U. Kreusler, professor in the agricultural academy at Poppelsdorf.

Professor Leopold Just, director of the Agricultural-Botanical Experiment Station at Karlsruhe, died August 30, 1891, at the age of 50 years.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING OCTOBER, 1891.

Division of Entomology:

Periodical Bulletin, vol. IV, Nos. 1 and 2, October, 1891.—Insect Life.

Weather Bureau:

Special Report, 1891.

Division of Statistics:

Report No. 89 (new series), October, 1891.—Condition of Crops; Yield of Grain per Acre; Freight Rates of Transportation Companies.

Office of Experiment Stations:

Experiment Station Record, vol. II, No. 12, July, 1891.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING OCTOBER, 1891.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF ARIZONA:

Bulletin No. 2, September 15, 1891.—Notes on some of the Range Grasses of Arizona; Overstocking the Range.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF CALIFORNIA:

Bulletin No. 94, September 23, 1891.—Composition of the Ramie Plant; Fertilizing Value of Greasewood.

GEORGIA EXPERIMENT STATION:

Bulletin No. 14, October, 1891.—Variety and Fertilizer Experiments with Oats; Variety Tests with Wheat; Variety Tests and Fertilizer Experiments with Vegetables.

KANSAS AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 21, August, 1891.—Second Report on Fungicides for Stinking Smut of Wheat.

Bulletin No. 23, August, 1891.—Smuts of Sorghum; Corn Smut.

MAINE STATE COLLEGE AGRICULTURAL EXPERIMENT STATION:

Annual report, part III, 1890.

Bulletin No. 3 (second series), September 1, 1890.—The Babcock Milk Test Adapted to Testing Cream.

MARYLAND AGRICULTURAL EXPERIMENT STATION:

Third Annual Report, 1890.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:

Bulletin No. 15, October, 1891.—Experiments in Greenhouse Heating; Special Fertilizers for Plants under Glass; Report on Varieties of Strawberries; Report on Varieties of Blackberries and Raspberries.

Meteorological Bulletin No. 33, September, 1891.

EXPERIMENT STATION OF MICHIGAN AGRICULTURAL COLLEGE:

Bulletin No. 75, July, 1891.—Fertilizer Analyses.

Bulletin No. 76, October, 1891.—Kerosene Emulsion.

NEW JERSEY STATE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 83, September 15, 1891.—Analyses and Valuations of Complete Fertilizers.

NEW YORK AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 33 (new series), July, 1891.—The New York State Fertilizer Control and Fertilizer Analyses.

Bulletin No. 34 (new series), August, 1891.—Comparison of Dairy Breeds of Cattle with Reference to Production of Butter.

Bulletin No. 35 (new series), August, 1891.—Some of the most Common Fungi and Insects, with Preventives.

Bulletin No. 36 (new series), September, 1891.—Small Fruits.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 31, September, 1891.—The Forcing of English Cucumbers.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 78*a*, July, 1891.—Meteorological Summary for North Carolina, April and May, 1891.

Bulletin No. 79*a*, August 15, 1891.—Meteorological Summary for North Carolina, June and July, 1891.

OHIO AGRICULTURAL EXPERIMENT STATION:

Bulletin vol. IV, No. 5, September 1, 1891.—The Wheat Midge.

RHODE ISLAND STATE AGRICULTURAL EXPERIMENT STATION:

Third Annual Report, part II, 1890.

Bulletin No. 11, June, 1891.—Fertilizer Law, Valuations and Analyses; Meteorological Summary.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 1 (new series), July, 1891.—Commercial Fertilizers.

TENNESSEE AGRICULTURAL EXPERIMENT STATION:

Bulletin vol. IV, No. 3, July, 1891.—The True Bugs of Tennessee.

TEXAS AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 17, August, 1891.—General Information Relating to the Texas Station.

AGRICULTURAL EXPERIMENT STATION OF UTAH:

Bulletin No. 8, August, 1891.—Silage.

VERMONT STATE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 26, September, 1891.—Maple sugar.

DOMINION OF CANADA.

DEPARTMENT OF AGRICULTURE:

Annual Report for the Province of Ontario, 1890.

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U. S. DEPARTMENT OF AGRICULTURE

OFFICE OF EXPERIMENT STATIONS

A. W. HARRIS, DIRECTOR

EXPERIMENT STATION RECORD

VOL. III, NO. 5

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EXPERIMENT STATION RECORD.

Vol. III. ISSUED DECEMBER, 1891. No. 5.

EDITORIAL NOTES.

To obviate the difficulties met with in field experiments, various methods have been suggested. The chief aim has been to bring as many conditions as possible under the control of the experimenter and to eliminate those irregularities of soil, moisture, and plant food which often vitiate the results of field experiments. For this purpose use has been made of small quantities of soil placed in pots or boxes or in small plats separated by partition walls sunk in the ground.

The leading representative of this tendency of experimental inquiry just now is Prof. P. Wagner, of the experiment station at Darmstadt, whose methods of experimenting with soil in pots have proven most useful and are coming to be widely adopted. Wagner's system consists essentially in using cylindrical pots of zinc to hold the soil, which is carefully prepared and thoroughly mixed so as to have the portions in the different pots as nearly alike as possible. Any desired soil can be used. The pots are placed on small platform cars which run on rails, are easily moved, and can be put under shelter when necessary to protect the plants from rain, hail, severe wind, or frost. To regulate the water supply, the pots are weighed by a convenient apparatus, and water is added as often as is necessary to maintain the percentage of moisture in the soil best fitted for the growth of the plants. Wagner also uses larger cylinders set in the soil. In these the water supply can not be regulated so well, nor can the plants be put under shelter.

Noteworthy as is the success of the system which Wagner has been elaborating for more than a decade, a success proven by his own results and confirmed by the experience of others who have followed his method, it does not meet all the needs, and other experimenters are trying to improve upon it. The plan of inclosing the soil in boxes, which was undertaken over a score of years ago by Wolff and Henneberg and has been prosecuted by Hanamann, Lawes and Gilbert, Wohltmann, and others, has several advantages over that of pot experiments. Larger quantities of soil are used so that more plants may be grown. The plants

have opportunity for more natural root development. The temperature of the soil in the boxes is subject to less fluctuations than in the small pots, and is more like that of the soil in its natural state. The conditions of growth are thus more nearly normal. With proper appliances the water supply can be kept under control, the water table maintained at any desired level, the drainage water collected, measured, and analyzed, and thus the statistics of income and outgo of water and plant food can be determined.

Plans of box experiments adopted in the experimental garden of the Agricultural Institute of the University of Halle by Dr. Wohltmann, and at the newly organized Experiment Station for Plant Culture in Dresden by Dr. Steglich, are given on pages 342–354 of the present number of the Record.

By this method many of the difficulties of field experimenting are avoided, most of its advantages are retained, and a number of very desirable features are added. The experiments are close at hand and more easily watched than in a distant field. Any desired soil or selection of soils can be used. Each soil can be carefully prepared, sifted free from stones, and thoroughly mixed, so that it shall be alike in all the boxes. The boxes are set in the ground and plants are grown in the spaces between them. We thus have a series of experimental plats, as in a field experiment, only on a smaller and more convenient scale. Each plat is entirely isolated, so that the plants of one plat can not feed upon the material of another, and is large enough for a number of plants to grow upon it and small enough to be managed with little labor. There are tubes for watering the soil from below and collecting the drainage water. The water supply can be regulated at will and made the same for all. Thus drouth and excessive moisture, which injure or ruin so many experiments in the field, are prevented, and two chief sources of error in field experiments—unevenness of soil and inequality of water supply in the different plats—are avoided. Data for the statistics of water supply and removal are found in the measurements of rainfall, water applied artificially, and drainage. Analyses of drainage water show the amounts of plant food removed thereby. These, with weights and analyses of soil, fertilizers, and crops, supply the statistics of gain and loss of the elements of plant food. The plants can be more easily cared for and better protected from depredations of animals and from disease than in field experiments. The quantities of produce are so small that the plants and their several parts can be easily measured, and can be weighed and analyzed with comparatively little labor. In short, this is a sort of field laboratory. It is a device for applying to field experimenting the accuracy of method and convenience of manipulation which are indispensable for the best success.

A method of field experimenting which has a number of the advantages of the box experiment, has been adopted at the Dresden Station and is described on pages 350, 351. Small plats are used. These are made

uniform by careful attention to the subsoil and thorough mixing of the surface soil. Soils of several kinds are tested side by side for comparison. The plan consists in removing the soil to the depth of a meter (39.3 inches) and replacing it by the soil chosen for the experiment, which may be brought from a distance. For the experiments now being planned at this station typical specimens of five of the most important kinds of soil in Saxony have been selected. These are placed in position so as to provide small fields of different typical soils side by side. Each field is divided into narrow plats about 4 square rods in area. The plats of each field are uniform in respect to physical and chemical characters of the soil, and if the subsoil is uniform in its water supply and drainage, as is supposed, they will all have the same quantities of water. The uniformity of soil and water supply makes these small plats better than large ones ordinarily are. The quantity of water can not be regulated as in the box experiments, nor can the statistics of income and outgo of plant food and water be determined.

Of course such arrangements as these are expensive. In Dresden, where labor is somewhat cheaper than in most places in the United States, the plant for twenty experimental boxes complete cost about $1,000. That for the same number of small plats prepared as above described, cost from $750 to three or four times as much, according to the expense of getting, preparing, and especially transporting the large quantities of soil. But if the expense is considerable at the outset the work of carrying on the experiment is less than in ordinary field experiments, because everything is conveniently at hand and the areas are small.

For its box experiments the Dresden Station is planning a study of the acquisition of atmospheric nitrogen by plants and soils. While the affiliated station at Tharand is investigating the action of bacteria in the assimilation of the nitrogen of the air by plants grown in artificial soil, the Dresden Station is to study the practical side of the subject by experiments in natural soil, so devised that the gain and loss of nitrogen may be accurately determined. To this end boxes are to be filled with soils of different kinds and lupines grown in them. Some will be treated with bacteria from soils in which lupines have been successfully cultivated, and thus the effects of the inoculation will be observed. Accurate account is to be kept of the amounts of nitrogen in the soil at the outset, the amounts removed by drainage water and in the plants that are harvested, and the amounts left in the soil at the end of the experiment, which is to last several years. The balance will show how much nitrogen the soil and plants have gained by the different treatments.—[W. O. A.]

The following information regarding experiment stations in Java has been furnished by Dr. H. Winter, for some time chemist of the West Java Sugar Experiment Station and later connected with the station in Middle Java. Though not statistically complete, it is nevertheless of interest as illustrating the progress of the experiment station enterprise there.

There are at present four experiment stations on the Island of Java. Three, which may be called sugar experiment stations, were organized and are supported by associations of sugar producers. The fourth, which is supported by the Government, is connected with the botanical garden at Buitenzorg, and is devoted to investigations of tropical plants, especially those of commercial importance in Java.

Of the three sugar experiment stations, one is situated at Kagok-Tegal in West Java, another at Samarang in Middle Java, and the third at Passoeroean in East Java. The oldest is the West Java Station, which was founded in 1885. It is under the control of an association of some thirty or forty sugar producers, who furnish the means for its support—about $16,000 annually—and appoint a committee from their number for its management. Every associate pays in proportion to the area he cultivates. At the time of its organization the working staff included a director, Dr. W. Krüger, and a chemist. The present director is Dr. Went.

Some of the results of the investigations at this station have been reported by Dr. Krüger in Dutch and also in German in a volume entitled *Berichte der Versuchs-Station für Zuckerrohr in West Java, Kagok-Tegal (Java)*, published in Dresden, Germany, in 1890. It contains accounts of three investigations by Dr. Winter and one by Dr. Krüger. Of those by Dr. Winter, the first, on Methods of Investigation for the Cane-Sugar Industry, describes studies on the determination of glucose in sugar juices, the determination of sugar in sugar cane, and the selection and investigation of average samples in field experiments; the second, on The Chemical Composition of Sugar Cane, treats of the distribution of sugar in sugar cane and the chemical constituents of sugar cane; the third, on Extraction of Cane Sugar from Sugar Cane, contains articles on certain materials which appear in the making of sugar, and on lime precipitation (without CO_2). That by Dr. Krüger is on Diseases and Enemies of the Sugar Cane, and is in three divisions. The first, on diseases due to animal parasites, treats of diseases caused by borers and *Physopoda*; the second, on diseases due to vegetable parasites, treats of blight, red spot of the leaves, rust, and a disease of the leaves caused by a sclerotium; the third treats of obscure diseases probably due to vegetable organisms. Among the nine plates accompanying the text are illustrations of *Scirpophaga intacta*; *Chilo infuscatellus*; *Diatræa striatalis*; *Grapholitha schistaceana*; *Thrips sacchari*, n. sp.; *Phlœothrips lucasseni*, n. sp.; *Tylenchus sacchari*; *Cercospora köpkei*, n. sp.; *Ustilago sacchari* (?), and *Uromyces kühnii*, n. sp.

A few months after the establishment of the West Java Station a second, similar in organization and purpose, was founded at Samarang, Middle Java. The members of the association which controls it contribute to its support in proportion to the amount of sugar produced each year. Its income averages about $20,000 per annum. It was first organized with Dr. Benecke, a botanist, as director, and a chemist as assistant. In connection with the station work there was also a course of instruction to about a dozen students.

The third sugar experiment station was started in 1886, in Passoeroean, East Java, on essentially the same plan as the one in West Java. Its income is over $24,000 per annum. The working staff includes Dr. Kramers as director and chemist, a vice director and botanist, a bacteriologist, and an assistant chemist. For manual services four helpers are generally employed.

The institutions mentioned above are working exclusively in the interest of the production of cane sugar, and are only in this limited sense agricultural experiment stations. The latter designation may, however, be properly applied to the station connected with the botanical garden of Buitenzorg. Its work is principally botanical, and, as above stated, it has to do with tropical plants, the development of which is so important in Java. Extensive investigations have been made with fertilizers at this as at the other stations, but their success has been interfered with by diseases which have attacked the plants.

It is probable that other stations will soon be organized in the interests of the production of coffee, quinine, tobacco, etc., and one especially for indigo.

The management of the stations is liberal. The buildings, especially the laboratories, are very substantial, and are provided with water, gas, and other conveniences. The equipments for the particular lines of investigations are excellent. The salaries are generous—$5,000 per year for directors, $2,500 to $3,750 for chemists, and $1,500 for assistants.

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Arizona Station, Bulletin No. 2, September 15, 1891 (pp. 12).

NOTES ON SOME OF THE RANGE GRASSES OF ARIZONA, J. W. TOUMEY, B. S.—This is a brief preliminary report on some of the most important grasses growing on the open mesa lands, in valleys, and on mountains. The species mentioned in the bulletin are *Bouteloua eriopoda*, *B. oligostachya*, *B. racemosa*, *B. hirsuta*, *B. aristidoides*, *B. havardii*, *Buchloe dactyloides*, *Hilaria mutica*, *H. jamesii*, *H. rigida*, *Aristida arizonica*, *A. purpurea*, *Pappophorium laguroideum*, *Panicum lachnanthum*, *P. bulbosum*, and *Muhlenbergia distichophylla*. Attention is called to the diminution of the pasturage on the ranges, due to overstocking. The close pasturing of the native grasses, combined with drouth, is causing the gradual extinction of the more valuable forage plants on many of the ranges.

Arkansas Station, Third Annual Report, 1890 (pp. 155).

FINANCIAL STATEMENT (p. 4).—An itemized account of expenditures by the station in 1890.

SHRINKAGE IN SILAGE (p. 5).—A brief tabulated statement of the amount of corn and sorghum stored in and of the silage taken from the station silo.

EXPERIMENTS WITH CORN, POTATOES, GRASSES, AND SUGAR BEETS (pp. 5–12).—*Corn after rye* (p. 5).—A brief tabulated record of the amount of rye and corn obtained from ten plats on which rye was harvested at different dates from April 9 to May 12, inclusive, and was followed by corn.

Corn, test of varieties (pp. 6, 7).—Tabulated data for 41 varieties grown in 1890. The results of 3 years' experiments indicate that White Giant Normandy, a late variety, is best suited to northwestern Arkansas.

Corn, fertilizer experiment (p. 8).—Tabulated data for twelve plats of sandy soil, on which cotton-seed meal, acid phosphate, and kainit, in different combinations, were compared with no manure for White Giant Normandy corn. The best results were obtained with cotton-seed meal combined with acid phosphate.

Potatoes, fertilizer experiment (p. 9).—A brief tabulated record of an experiment in which different fertilizers were compared with no manure on seventeen plats where early potatoes were planted by the trench method. The highest yield was with a combination of acid phosphate, kainit, and dried blood.

Grasses and forage plants (p. 10).—A tabulated record of the condition December 8, 1890, of 26 species of grasses and forage plants sown on thin, sandy soil at the station in the spring of the same year. Japan clover is the only kind reported in good condition.

Sugar-beet experiments (pp. 11, 12).—A brief tabulated record of the yields of 13 varieties of sugar beets, and of American Imperial sugar beet on sixteen plats where different amounts of cotton-seed meal, acid phosphate, and kainit, singly and two by two, were compared with no manure. The highest yield, 13,280 pounds per acre, was with 50 pounds of acid phosphate.

REPORT OF CHEMIST, G. L. TELLER, B. S. (pp. 13–28).—The author entered upon the duties of his office September 20, 1890, succeeding C. B. Collingwood, B. S. The report includes notes and tabulated data on analyses of sorghum, sugar beets, and fertilizers.

Sorghum analyses.—The work on sorghum during 1890 comprised a complete analysis of 352 samples of juice, besides a partial analysis of 225 other samples, made in connection with (1) an experiment to study the effect of fertilizers on the yield of sugar, (2) a test of varieties, and (3) an examination of juice as an index to the selection of seed.

Effect of fertilizers on yield of sugar.—Kainit, acid phosphate, and cotton-seed meal in different amounts and combinations were compared with no manure on 40 fiftieth-acre plats planted with Early Orange sorghum. The highest per cent of sucrose was obtained when the three fertilizers were combined, and in general the application of kainit seems to have had "a beneficial influence upon the amount of sugar in the canes and juice." This is in agreement with the results of a similar experiment reported in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 317).

Test of varieties.—A tabulated record of analyses of 18 varieties. "In nearly every case the degree Brix of the juices analyzed here is lower than in that of the cane from which the seed was selected. All of the varieties polarized on an average more than 14 per cent of sugar. Of the 6 varieties the juices of which showed more than 15 per cent of sugar, all but one (Link Hybrid) were said to be crosses. The same varieties show a relatively high purity coefficient."

Sugar-beet experiments.—Tabulated analyses are given of samples of beets grown in the experiment referred to above. In only one case (White Imperial 11.8 per cent) was the per cent of sucrose in the juice above 9 per cent.

Fertilizer analyses.—Analyses of 6 samples of commercial fertilizers.

Report of Horticulturist, J. McNeil, B. S. (pp. 29–61).—A report of experiments with tomatoes, cucumbers, apples, strawberries, plums, apricots, and grapes.

Tomatoes (pp. 29–31).—Nitrate of soda, kainit, acid phosphate, and cotton-seed meal were applied to Paragon tomatoes. The largest and most profitable yield (528 bushels per acre) was in the row fertilized with 800 pounds of nitrate of soda per acre.

Cucumbers (pp. 32, 33).—The yields are reported for 13 varieties of cucumbers, planted in hills in the ordinary way and around a pit filled with stable manure. The aggregate yield favors the latter method of planting, but 5 of the varieties did better when planted in the ordinary way.

Apples (pp. 33–38).—A list is given of 110 varieties, together with 16 of crab apples, growing in the station orchard. An experiment is described in which apples were kept in a storehouse, the temperature of which was kept between 40° and 50° F by the use of ice. The profit, as estimated, was sufficient to warrant the repetition of the experiment. Apples dipped in hot paraffin did not keep any better than those left untreated.

Strawberries (pp. 39–45).—A reprint of Bulletin No. 13 of the station (see Experiment Station Record, vol. II, p. 198).

Plums and apricots (p. 46).—A brief note on the condition of the varieties of plums and apricots growing at the station.

Grapes (pp. 46–61).—Tabulated data for 138 varieties planted in the spring of 1888 and fruiting for the first time in 1890. The yield, with few exceptions, was poor. This is attributed to the following causes: "(1) The evident unfitness of many of the varieties for this locality, (2) the prevalence of rot, (3) the depredations of the grape leaf folder, and (4) the unfavorable situation of the vineyard."

A new insecticide for the cotton worm, A. E. Menke, D. Sc., and G. C. Davis (pp. 62–69).—A reprint of Bulletin No. 15 of the station (see Experiment Station Record, vol. II, p. 318).

Report of Entomologist, C. W Woodworth, M. S. (pp. 70–97, figs. 2).—Brief notes are given on the following insects which injured crops in Arkansas in 1890: Cutworms, white grub, grain plant louse, grape leaf folder, cotton worm, and bollworm. Great differences in the amount of injury to the foliage of different varieties of grapes by the grape leaf folder were observed. Hybrid varieties were especially attractive to the worm, while those of the species Vulpina suffered comparatively little injury. An article on cotton worms is reprinted from Bulletin No. 12 of the station (see Experiment Station Record, vol. II, p. 198) and another on the effects of arsenites on plants from Bulletin No. 14 of the station (see Experiment Station Record, vol. II, p. 198). Some additional notes are inserted in the latter article with reference to the relation between the strength of the poison used and the injury produced, and the differences in the amount of injury due to differences in

the time of application. The following tables contain a summary of experiments in which the arsenites were used in the proportion of 1 part by weight to 100 or more parts of water:

A series of 240 experiments on the oak gave the following results:

Percentages of injury to oak leaves.

Poison used.	1-100	1-200	1-400	1-600	1-800	1-1000
Fresh white arsenic	32	25	7	3	6	2
Old white arsenic	100	100	100	100	99	99
Paris green	100	100	100	99	97	92
London purple	93	91	80	34	44	25

A series of 320 experiments on the tomato gave the following data:

Percentages of injury to tomato leaves.

Poison used.	1-100	1-200	1-400	1-800	1-1600	1-3200	1-6400	1-12800
Fresh white arsenic	0	0	0	0	0	0	0	0
Old white arsenic	*100	*100	*100	*100	100	100	100	1
Paris green	*100	*100	*100	*100	*100	*100	150	3
London purple	*100	*100	*100	*100	*100	3	1	0

* Stems also killed.

To determine how much difference is due to the time of application 216 applications were made on apple, grape, and peach leaves, care being taken to make the applications entirely parallel as to number, age of leaf, and method of application.

Percentages of injury to apple, grape, and peach leaves.

Poison used.	First day.	Second day.	Third day.	Fourth day.
White arsenic	14	58	51	9
Paris green	52	36	27	15
London purple	67	60	58	30

These applications were all made during 1 month, so that they probably show only the effects of the different atmospheric conditions. * * * It seems very evident that the condition of the leaf, which is dependent upon the atmospheric condition at the time, is the chief cause of this variation. The fact that poison applied dry and kept dry can be applied in almost any quantity to a plant without injury would prove that the critical time is dependent upon the period of application and subsequent rains and dews. Leaves do not have the same power to absorb moisture at all times.

REPORT OF VETERINARIAN, R. R. DINWIDDIE, V. S. (pp. 98–122, figs. 4).—This contains an account of investigations of Southern cattle plague by the author. Reference is made to experiments published in Bulletin No. 11 of the Missouri Station (see Experiment Station Record, vol. II, p. 160) and Bulletins Nos. 7, 8, 9, and 10 of the Nebraska Station (see Experiment Station Record, vol. I, p. 123). Experiments by the author in the preventive inoculation of cattle in Arkansas and

in the cultivation and production of the disease by inoculations from different organs of diseased cattle and the manure of Southern cattle, gave negative results. Further experiments failed to show any particular bacterium as the cause of the disease. The intracorpuscular bodies, first described by Dr. T. Smith of the Bureau of Animal Industry of this Department, were observed by the author in materials from the spleen and kidneys.

EXPERIMENTS WITH SWEET POTATOES, R. L. BENNETT, B. S. (pp. 123–128).—These were at the branch station at Newport, Arkansas. The yields of 9 varieties tested on sandy soil in 1890 are given, together with a tabulated record of the chemical composition of the tubers and vines of the varieties tested, as determined by the station chemist, and brief tabulated records of experiments with fertilizers, on high *vs.* low culture, and on the effect of the removal of the vines on the yield of tubers. The best results were obtained in the use of kainit and low culture. The yield decreased 44.5 bushels per acre where the vines were removed.

EXPERIMENTS WITH GRASSES AND LEGUMES, R. L. BENNETT, B. S. (pp. 129, 130).—A brief account of 2 years' tests of 33 varieties of grasses and legumes on the sandy soil of the branch station at Newport. None of the plants tested could be profitably grown for hay without a liberal use of fertilizers. "Orchard grass, timothy, tall fescue, tall meadow oat grass, Kentucky blue grass, alfalfa, redtop, meadow fescue, and Bermuda grass having succeeded better than others, are being further experimented with by the application of fertilizers."

FIELD PEAS, R. L. BENNETT, B. S. (pp. 130–133).—Brief notes on 9 varieties of peas, and a table showing the comparative feeding values of pea hay, timothy hay, and millet.

FEEDING EXPERIMENT WITH STEERS, R. L. BENNETT, B. S., AND A. E. MENKE, D. SC. (pp. 134–146).—The chief object of this experiment was "to determine the effects, if any, of cotton-seed products, variously combined, upon the quality of the flesh and fat" when used for fattening animals for beef. Eleven range steers, from 2 to 2½ years old, and varying in weight from 560 to 792 pounds, were fed in stalls for a period of 90 days, as follows:

Lot 1, cotton-seed meal and cotton-seed hulls.

Lot 2, corn and pea-vine hay.

Lot 3, cotton-seed meal, cotton-seed hulls, and pea-vine hay.

Lot 4, cotton seed, cotton-seed hulls, and pea-vine hay.

Lot 5, cotton seed and pea-vine hay.

The rations were the same in kind throughout the trial, but the amount fed was regulated by the individual appetites. At the close of the experiment the animals were immediately shipped to the Armour Packing Company at Kansas City, Missouri, where they were slaughtered under the supervision of the station. The company determined the dressed weight, the weight of tallow and of rendered tallow, and

the melting point of the tallow, and also made careful examinations of the quality of the beef and tallow from each animal. These data are reported, together with statements of the amount and cost of the food consumed by each animal, the total gain in live weight, the cost of food per pound of live weight gained, and analyses of each of the feeding stuffs. Differences due to individuality were very noticeable in animals of the same lot, so that exact conclusions as to the relative effects of the different rations are impossible. The cost of food per pound of gain, not taking the value of the manure into account, was lowest in the case of lot 1 (cotton-seed meal and hulls), lot 4 (cotton seed, cotton-seed hulls, and pea-vine hay) ranking second in this respect. The cost was highest with lot 2 (corn and pea-vine hay), being more than two and a half times as large as with lot 1.

There was no difference in appearance due to the food between the lot fed cotton-seed meal and cotton hulls and the lot fed corn and pea-vine hay. * * * Summing up the data obtained from the feeding and slaughtering of the eleven steers, the conclusion is that there were not detected through the usual manner of manipulating beef, any detrimental effects from cotton-seed products fed to the animals.

EXPERIMENTS WITH FERTILIZERS FOR COTTON, B. M. BAKER (pp. 147–149).—The yields are tabulated for cotton grown with the use of cotton-seed meal, dried blood, leather scrap, sulphate of ammonia, and nitrate of soda; with a mixture of six parts of cotton-seed meal and two parts of acid phosphate, and the same with one part of kainit; and with cotton-seed meal, acid phosphate, and kainit, used singly, two by two, and all three together. No conclusions are given, except that of the two mixtures the one containing kainit generally gave the largest yields.

Varieties of cotton (p. 147).—Tabulated yields for 21 varieties of cotton.

Kansas Station, Bulletin No. 22, August, 1891 (pp. 25).

SMUT OF OATS IN 1891, W. A. KELLERMAN, PH. D. (pp. 73–81).—Previous accounts of statistics and experiments on oat smut (*Ustilago avenæ*) may be found in Bulletins Nos. 8 and 15 and in the Annual Report of the station for 1889 (see Experiment Station Record, vol. I, p. 216, and vol. II, pp. 342 and 638). Tabulated data are given for counts of the amount of oat smut in 1891 in fields on seven different farms near Manhattan, Kansas. Of the 28,807 heads counted, 1,660 were smutted, showing the average percentage of smut to be 5.76. The amount of smut in different fields varied from 3.2 to 7.92 per cent. The results of experiments with fungicides are also tabulated. Potassium sulphide was used in solutions varying from $\frac{1}{8}$ to 20 per cent during from 5 minutes to 24 hours. In one case calcium sulphide was used, and in several instances different amounts of sulphur. The potassium sulphide proved an effective fungicide this year as in 1890. "It may be used in a weak solution (say 1 pound to 20 gallons of water), in which the seed

should be soaked 24 hours; or it may be used in a solution twice as strong, allowing the seed to remain in it only 10 or 12 hours.

In previous experiments, reported in the Annual Report of the station for 1889 and in Bulletins Nos. 15 and 21 (see Experiment Station Record, vol. II, pp. 342 and 640, and vol. III, p. 225), an extra increase of yield was observed on the plats treated with hot water or potassium sulphide. A further test of this matter in 1891 is reported in detail in tables and illustrated in diagrams.

The following is a summary of the results:

Treatments (each on 6 plats).	Yield of grain per acre.	Increase of yield.	Extra increase of yield.
	Bushels.	*Per cent.*	*Bushels.*
Untreated	53.10	....	....
Hot water, 143½° F., 5 minutes	62.10	16.76	5.75
Hot water, 134½° F., 10 minutes	62.10	16.76	5.75
Hot water, 134½° F., 3½ minutes (previously soaked 3 hours)	60.75	14.40	4.40
Hot water, 132½° F., 15 minutes	60.30	13.56	3.95
Hot water, 132½° F., 10 minutes (not cooled)	64.35	21.18	8.00
Potassium sulphide, ½ per cent solution, 24 hours	*58.50	10.17	2.15
Results expected from simply replacing smutted heads with sound ones	56.35	6.11	....

* The seed being damp and swollen a smaller quantity per acre was drilled.

TESTS OF FUNGICIDES TO PREVENT LOOSE SMUT OF WHEAT, W. A. KELLERMAN, PH. D. (pp. 81–90).—A summary of available information regarding loose smut of wheat (*Ustilago tritici*) was given in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 342), and accounts of experiments with fungicides for stinking smut of wheat (*Tilletia fœtens* and *T. tritici*) may be found in Bulletins Nos. 12 and 21 of the station (see Experiment Station Record, vol. II, p. 220, and vol. III, p. 225). The amount of loose smut found on 25 varieties of wheat grown at the station in 1891, as stated in a table, ranged from 0 to 16 per cent. Tabulated data are given for experiments with 54 different methods of treatment tested on as many plats, alternate plats remaining untreated. The fungicides used were Bordeaux mixture, eau celeste, copper sulphate, potassium bichromate, copper nitrate, verdigris, copper chloride, mercuric chloride, Ward's Seed Manure, and hot water. Very little smut appeared on the untreated plats, and the data reported do not conclusively favor any of the treatments.

SPRAYING TO PREVENT WHEAT RUST, W. A. KELLERMAN, PH. D. (pp. 90–93).—Notes and tabulated data for an experiment in which flowers of sulphur, potassium sulphide, chloride of iron, and Bordeaux mixture were applied singly at intervals usually of 8 days from April 21 to July 2, 1891, inclusive, on Fife and Blue Stem spring wheat, Chevalier, Four-Rowed, Melon, Saal, Prize Prolific, and Algerian barley, and Black Winter oats, with a view to preventing red and black rust (*Puccinia* sp.). The fungicides apparently had little if any effect. However, attention is called to the fact that frequent rains may have materially interfered with the success of the experiment.

Kansas Station, Bulletin No. 23, August, 1891 (pp. 15).

EXPERIMENTS WITH SORGHUM SMUTS, W. A. KELLERMAN, PH. D. (pp. 95–101, plates 3).—Two species of smut have been found on sorghum in Kansas, *Ustilago sorghi*, which attacks the individual grains, and *Ustilago reiliana*, which converts the whole head into a large black mass. *Ustilago sorghi* (Passerini in Thüm. Herb. myc. oec. n., 63) has been reported in this country from Washington, D. C.; Madison, Wisconsin; New York; Lincoln, Nebraska; and Manhattan and Sterling, Kansas, on plants grown from foreign seed.

Ustilago reiliana (Kühn in Rabenhorst, Fungi europæi exsiccati, cent., 20, No. 1988) was found in 1890 at Manhattan and Sterling, Kansas and in New Jersey, on plants from foreign seed. In a preliminary test in a greenhouse at the station with the seed of Red Liberian, Rangoon, Early Amber, White Kaffir Corn, and a variety from Calcutta the plants in nine of the fifteen pots in which infected seed was planted, produced smutted heads (*Ustilago sorghi* in seven cases and *U. reiliana* in two cases). A field experiment with infected seed, and with potassium sulphide, chloride of iron, and hot water as fungicides to prevent the smut, is also reported in notes and tables. The untreated plats gave from 1 to 3.3 per cent of smutted heads and there was no smut where either potassium sulphide or hot water was used. "The artificial infection of the seed does not seem to be successful."

EXPERIMENTS WITH CORN SMUT, W. A. KELLERMAN, PH. D. (pp. 101–105).—Attempts in the greenhouse and in the field to infect corn by adding a quantity of the spores of corn smut (*Ustilago zeæ-mays*) to the seed were unsuccessful. Spraying corn plants with Bordeaux mixture, chloride of iron, or potassium sulphide did not prevent the development of corn smut. Details are given in notes and tables.

Massachusetts State Station, Bulletin No. 41, September, 1891 (pp. 16).

METEOROLOGY (p. 1).—Meteorological summary for July and August, 1891.

COMMERCIAL FERTILIZERS (pp. 2, 3).—Tabulated analyses of 23 samples of commercial fertilizers, including tankage and bone.

FEEDING EXPERIMENTS WITH MILCH COWS, C. A. GOESSMANN, PH. D. (pp. 4–16).—These experiments were designed to compare the effects of like amounts of cotton-seed meal, old-process linseed meal, and gluten meal on the cost of food and the quantity and quality of milk produced. These materials were each fed with 3 pounds of corn meal and 3 pounds of wheat bran, and coarse foods consisting of rowen hay, corn stover or hay, and a mixed silage made of equal parts by weight of green fodder corn and green soja beans. The rations fed each

period in addition to the 3 pounds of corn meal and 3 pounds of wheat bran, which were fed at all times, were as follows:

Period 1, 3 pounds cotton-seed meal and rowen hay *ad libitum.*
Period 2, 3 pounds gluten meal and rowen hay *ad libitum.*
Period 3, 3 pounds linseed meal and rowen hay *ad libitum.*
Period 4, 3 pounds cotton-seed meal, 5 pounds rowen hay, and mixed silage *ad libitum.*
Period 5, 3 pounds gluten meal, 5 pounds rowen hay, and mixed silage *ad libitum.*
Period 6, 3 pounds gluten meal and corn stover *ad libitum.*
Period 7, 3 pounds cotton-seed meal and corn stover *ad libitum.*
Period 8, 3 pounds cotton-seed meal and rowen hay *ad libitum.*
Period 9, 3 pounds gluten meal and rowen hay *ad libitum.*

In all nine grade cows in different stages of the milking period were used in the experiment, but at no time were there more than six cows included in the test, some of the cows being replaced by others when their milk yield became too small. The experiment lasted from November, 1890, to June, 1891. During this time the gluten meal ranged in price from $24.50 to $28, the linseed meal from $26 to $27, and the cotton-seed meal from $26 to $28 per ton. The tabulated record for each cow includes the history of the cows; the analyses of the corn meal, wheat bran, cotton-seed meal, old-process linseed meal, gluten meal, rowen hay, corn and soja bean silage, and corn stover, with reference to both food and fertilizing ingredients; the amount of each food consumed; the nutritive ratio of each ration; yield and composition of the milk; and the live weight gained during the feeding periods.

[With regard to the yield of milk,] almost without an exception changes in the coarse fodder affected the results more seriously than changes in the grain. * * * Mixed silage with rowen in place of corn stover in some instances raised the daily yield of milk more than 3 quarts; allowing 3 cents per quart of milk, makes the former (mixed silage and rowen) the cheaper coarse fodder article of the two. These results are noticeable without reference to the particular combination of grain used in either case.

The conclusions of the author are that (1) at the prevailing market prices there was no marked difference in the effects of the cotton-seed meal, gluten meal, and old-process linseed meal on the gross cost of the rations. Making the usual allowances for the value of the manure, the "3 pounds of cotton-seed meal are 0.94 cent cheaper than 3 pounds of gluten meal, and 0.22 cent cheaper than 3 pounds of old-process linseed meal." (2) With regard to the milk yield, where the coarse fodder consisted of rowen hay alone "cotton-seed meal leads in five out of six cases," and where silage and hay or corn stover were fed "the gluten meal competes well with cotton-seed meal." (3) "The density of the milk in case of the same cow varied but little during the experiment; the notable changes were apparently in a controlling degree due to the particular condition and individuality of the cow used in the trial."

The superior feeding effect of green soja beans as a coarse fodder constituent in the diet of milch cows, has been shown in our summer feeding experiments of 1890, reported in the Annual Report of the station for 1890, pp. 39–54 [see Experiment Station Record,

vol. III, p. 153]. The influence which an addition of an equal weight of nearly mature soja beans exerts on the composition of corn silage will be seen from a comparison of the following analyses:

Composition of dry matter of corn silage and corn and soja bean silage.

	Corn silage.	Corn and soja bean silage.
	Per cent.	*Per cent.*
Crude ash	6.73	11.04
Crude cellulose	26.90	27.84
Crude fat	3.27	5.35
Crude protein	8.97	14.27
Nitrogen-free extract	54.13	40.50
Total	100.00	100.00

The clear corn silage was obtained from the same lot of fodder corn which served for the production of the mixed silage. The silos were in both cases filled in the same way, and as far as practicable at the same time; they were of corresponding size and contained fairly even quantities of vegetable matter. Both were opened for general use at about the same time—4 months after filling. The samples which served for the analyses represent in each case the average of the silage obtained by cutting in a vertical direction through the contents of each silo. The composition of the dry vegetable matter of the mixed silage compares well with that of a medium quality of red clover hay.

Massachusetts Hatch Station, Bulletin No. 15, October, 1891 (pp. 16).

EXPERIMENTS IN GREENHOUSE HEATING, S. T. MAYNARD, B. S. (pp. 3–7).—Reference is made to previous experiments in which steam and hot-water systems for heating greenhouses were compared, as reported in Bulletins Nos. 4, 6, and 8 of the station (see Experiment Station Record, vol. I, pp. 82 and 225, and vol. II, p. 104). This article contains an account of experiments in the two greenhouses previously used, to test overbench as compared with underbench heating. The hot-water system was used in both houses, and each house was divided into north and south sections, "in the former of which were grown coleus, roses, and other plants requiring a high temperature, while in the latter were grown lettuce, carnations, and other plants requiring a lower temperature." The results of an experiment begun December 1, 1890, and ended April 12, 1891, are recorded in three tables. One of these contains the daily record of the temperature of the house and the amount of coal consumed for each day of January; the second gives the average temperatures and the amounts of coal consumed for each month; the third shows the distribution of heat through the houses during different weeks. It was found that "while the average temperature of the water as it came from the boiler in the west house with pipes over the benches, was 4.81° higher than that from the east boiler, where the pipes ran under the benches, the house temperature was only 0.25° higher." One hundred and seventy-nine pounds more coal was consumed in the west house than in the east one. The circulation of the hot water in

the pipes over the benches was more rapid and regular than where the pipes ran under the benches. As regards the growth of plants, the results with carnations, lettuce, cuttings, and flower seed were in favor of the underbench piping. The blossoms of nearly mature or budding plants came out more quickly where the pipes were over the benches. The heat was more equally distributed through the houses where the pipes were under the benches.

SPECIAL FERTILIZERS FOR PLANTS UNDER GLASS, S. T. MAYNARD, B. S. (pp. 7, 8).—These experiments were in continuation of those reported in Bulletin No. 10 of the station (see Experiment Station Record, vol. II, p. 235), and were carried on in the greenhouses above mentioned. During 31 weeks the following numbers of carnation blossoms were obtained with the use of different fertilizers: Nitrate of potash 1,261, nitrate of soda 1,353, sulphate of ammonia 1,345, sulphate of potash 1,475, nitrate of potash 1,601, dissolved boneblack 1,069. The results of 5 experiments made in this line have varied; 3 favored boneblack, 1 sulphate of ammonia, and 1 nitrate of potash. Sulphate of potash stood second in each one of them.

TESTS OF VARIETIES OF SMALL FRUITS, S. T. MAYNARD, B. S. (pp 8, 16).—Tabulated data are given for 93 varieties of strawberries, 16 of blackberries, 19 of red raspberries, and 13 of blackcap raspberries, with brief descriptive notes on a few of the varieties. Injuries to strawberries by the black paria (*Paria aterrima*) and by rust (*Ramularia fragariæ*) are reported. Some varieties of blackcap raspberries suffered seriously from anthracnose (*Macrosporium punctiform*). The following varieties are especially recommended: *Strawberries.*—Beder Wood, Bubach No. 5, Haverland, Belmont, Warfield, Eureka, Middlefield, Sharpless, and Crescent. *Blackberries.*—Of the varieties fully tested, Agawam, Taylor Prolific, and Snyder; of the newer varieties, Erie, Minnewaski, Fred, and Stone Hardy. *Red raspberries.*—Marlborough, Cuthbert, and Hansel.

Michigan Station, Bulletin No. 75, July, 1891 (pp. 11).

FERTILIZER ANALYSES, R. C. KEDZIE, M. A.—The text of the State fertilizer law and a discussion of the object of inspection of fertilizers are given, together with tabulated analyses of 40 brands of fertilizers, including bone and "azotine," collected in the State during 1891.

Michigan Station, Bulletin No. 76, October, 1891 (pp. 16).

KEROSENE EMULSION AND NOTES ON INSECTS, A. J. COOK, M. S., AND G. C. DAVIS, M. S. (figs. 8).—Reference is made to previous statements regarding kerosene emulsion in Bulletins Nos. 58 and 73 of the station (see Experiment Station Record, vol. II, pp. 63 and 730). Formulas are given for kerosene emulsion with soft and hard soap, kerosene

and milk emulsion, and kerosene and pyrethrum emulsion. Experiments by the author and others are cited to show that kerosene emulsion is an effective insecticide for lice on cattle, horses, and hogs, and for ticks on sheep; and for the rose chafer (*Macrodactylus subspinosus*), the hollyhock bug (*Orthotylus delicatus*), the yellow-lined currant bug (*Pœcilocapsus lineatus*), plant lice, pear and cherry slug (*Eriocampa cerasi*), and pea weevil (*Bruchus pisi*). The pyrethrum kerosene emulsion was also successfully used for the rose chafer, the hollyhock bug, and the yellow-lined currant bug, and the author believes that this insecticide will be effective for plant lice. Both emulsions have been found destructive to the eggs and larvæ of the squash bug (*Anasa tristis*), but failed to kill the mature bugs.

A large number of experiments on different kinds of plants have indicated that one part of kerosene to fifteen of the hard-soap solution is safe on all plants. Where soft soap is used the amount of soap will in many cases need to be reduced. When pyrethrum is used with kerosene, one part of kerosene to twelve of the soap solution is recommended. Hot water (130° to 150° F.) was successfully applied with a common nozzle to plants attacked by the rose chafer. The experience of the author leads him to believe that this remedy can be used only on warm days. The bulletin also contains descriptive notes on the hollyhock bug, yellow-lined currant worm, oak caterpillar (*Edema albifrons*), white pine sawfly (*Lophyrus abbottii*), and a white pine sawfly parasite (*Perilampus hyalinus*).

New Hampshire Station, Second Annual Report, 1889 (pp. 72).

REPORT OF DIRECTOR, G. H. WHITCHER, B. S. (pp. 7–62, plate I).—This consists of a brief survey of the work of the year; abstracts of Bulletins Nos. 5, 6, 7, and 8 of the station (see Experiment Station Record, vol. I, pp. 127, 130, 255); and a plan of the station grounds.

GROWTH OF TIMOTHY GRASS, F. W. MORSE, B. S. (pp. 63–69).—This is a study of the changes in the nutritive constituents of timothy grass during its growth, with a view to finding the best time for cutting. Analyses are given of timothy cut every 5 days from June 4 to July 31, together with the yield of green grass, and the calculated amounts of digestible food ingredients for each cutting. The following are the author's conclusions:

Timothy grass grows very rapidly until the blossom appears. Its fastest growth is between the appearance of the head and beginning of bloom.

The amount of grass per acre increases until the time of blossoming; it then decreases. The decrease is due to loss of water.

Dry substance steadily increases until the plant forms seed.

The young grass is richest in fat and protein. The mature grass is richest in carbohydrates (or fiber and nitrogen-free extract).

Timothy yields the largest amount of digestible protein when cut at the beginning of bloom.

The total amount of digestible matter is largest when the grass has passed out of blossom or gone to seed.

MISCELLANEOUS ANALYSES (pp. 69–71).—Analyses are given of mixed feed and hay heated in the mow with reference to food ingredients, and of Bellamy bone phosphate, tobacco and sulphur, muck, milk, butter, Insect Exterminator, and paint.

FINANCIAL STATEMENT (p. 72).—Report of the receipts and expenditures of the station for the fiscal year ending June 30, 1889.

New Jersey Stations, Annual Report, 1889 (pp. 355).

REPORT OF TREASURER OF STATE STATION, J. NEILSON (p. 11).—This is for the calendar year 1889.

REPORT OF DIRECTOR, M. E. GATES, PH. D. (pp. 13–22).—This is an outline statement of the work of the stations during 1889. Special reference is made to the loss sustained by the stations in the death of the former director, George H. Cook, LL. D., which occurred September 22, 1889.

FERTILIZERS, E. B. VOORHEES, M. A. (pp. 23–101).—*Fertilizer statistics* (pp. 24–29).—This includes statistics as to the amount and value of the fertilizers sold in the State during 1889, and a comparison of prices, amount, and quality with those of each year from 1882 to 1888.

A report from forty out of the fifty-six firms in the State dealing in fertilizers, including those having the largest sales, indicated that during 1889 they sold within the State 32,246 tons of fertilizers, valued at $1,106,223.

The complete manures represent 74 per cent of the total number of tons sold and 77 per cent of the total value of all sales. * * * [A comparison of the prices in 1889 with those in previous years] shows that the average prices for these complete fertilizers fell steadily from 1882 to 1887, when it was 15 per cent lower, and that the average price of this year [1889] is about 4 per cent higher than that of 1887 and 1888. * * *

[It is further shown that] the decline in the prices of complete fertilizers from 1882–'87 was not accompanied by a corresponding decrease in the absolute amounts of plant food delivered to consumers, and the increase in price for 1889 was not accompanied by any increase in the amount of plant food delivered to consumers.

Commercial relations of fertilizers (pp. 29–101).—Under this heading are given a comparison of the wholesale and retail prices of fertilizing ingredients from 1885 to 1889; a monthly review of the prices of crude fertilizing ingredients during the year; the average retail prices of nitrogen, phosphoric acid, and potash from different sources since 1885; a popular discussion of the sources of supply of nitrogen, phosphoric acid, and potash; general suggestions as to how to buy and how to use commercial fertilizers; abstracts from the State fertilizer law; a description of the station's method of collecting samples of the fertilizers sold within the State; the schedule of trade values of fertilizing ingredients for 1887, 1888, and 1889; and analyses of 239 samples of commercial fertilizers, including bone, fish scrap, horse meat, and kainit, collected in the State

during 1889, together with samples of "tailings from concentrating iron ore," flue dust from iron works, and tomato pomace.

EXPERIMENTS WITH NITRATE OF SODA ON TOMATOES, E. B. VOORHEES, M. A. (pp. 102–127).—A reprint of Bulletin No. 63 of the station (see Experiment Station Record, vol. I, p. 261).

FIELD EXPERIMENTS WITH FERTILIZERS, E. B. VOORHEES, M. A. (pp. 127–153).—*Fertilizers on clover* (pp. 128–132).—In 1882 a series of experiments was commenced under the direction of the station on the farm of Mr. A. P. Arnold, to determine (1) "the effect of barnyard manure upon a rotation of crops compared with the effects of the leading elements of plant food used separately and in combinations; (2) the financial results which follow the use of commercial fertilizers." The rotation consisted of corn, sweet potatoes, clover and millet, and clover. The soil is described as "a very sandy loam, easily tilled, responsive to fertilizers, and especially suitable for the cultivation of sweet potatoes, berries, and small fruits." The experiment included 11 tenth-acre plats, and has been continued each year up to 1889, when clover was the crop raised. Each plat received the same treatment from year to year except in 1889, when no fertilizers were applied on any of the plats. On seven of the plats nitrate of soda, superphosphate, and muriate of potash had been used singly, two by two, or all three combined; plaster and barnyard manure had each been applied on one plat; and two plats had received no fertilizer during the 8 years. The yield of clover in 1889, the value of each previous year's crop, the total value of the crops for 8 years, and the cost of fertilizers during this time are tabulated for each of the eleven plats. The financial results for the 8 years show that where nitrate of soda or superphosphate, alone or combined, or plaster was used the total value of the crops, after deducting the cost of manures, was less by from \$11.96 to \$24.04 per plat than where no fertilizer was used. In the other cases there was a gain in net value over the unfertilized plats varying from \$63.52 to \$157.33 per plat, the largest gain occurring where barnyard manure had been used. A considerably larger amount of fertilizing ingredients was supplied by the barnyard manure than by the complete fertilizer composed of nitrate of soda, muriate of potash, and superphosphate. "While profit has accrued from the continued use of barnyard manure in large quantities, the yields have not only not been in proportion to those quantities, but the proportions of the elements removed in the crops have not been in the proportions in which they have been supplied in the manure."

Fertilizers on peach trees (pp. 133–137).—This experiment has been in progress on the farm of Mr. S. C. Dayton since 1884, the fertilizers used being the same as in the preceding series of experiments. The results are tabulated for 1889, and compared with those in 1887 and 1888. "The best yields secured in 1889 were from those plats upon which potash had been applied, the highest yield, 166.7 baskets, being where a mixture of potash and nitrate of soda was used. This result is, as Mr.

Dayton says, contrary to all precedent, superphosphate having been the ruling element on all crops upon his farm in previous years."

Canada ashes, domestic ashes, dissolved South Carolina rock, and Orchilla guano (pp. 137–140).—This is a comparison of these materials on the farm of Mr. A. P. Arnold for 5 years, the rotation of crops being the same as that given above. One hundred bushels of the ashes, 1,000 pounds of the rock, or 1,000 pounds of the Orchilla guano per acre were each used on one plat. The results are tabulated for each year. "The best yields were secured from the large dressings of Canada ashes."

Fertilizers on oats (pp. 140–142).—On two different farms experiments were made in which 150 pounds of muriate of potash and 300 pounds of dissolved boneblack per acre were used alone or combined on 3 tenth acre plats, and 2 plats remained unfertilized. The results are tabulated. "Owing to the unfavorable conditions existing this year very little has been gained by these experiments, and a further study of this crop will be made."

Fertilizers on potatoes and silage corn (pp. 142–146).—Field experiments to test "(1) the effect of potash when used alone; (2) the relative effect of equal weights of actual potash derived from muriate of potash and from kainit; and (3) the effect of common salt," were made on the college farm and at seven other farms in the State, four experiments being with corn and four with potatoes. The plats at the college farm were one twentieth-acre each; those in the other experiments one tenth-acre each. In the corn experiments muriate of potash 150 and 200 pounds, kainit 600 and 800 pounds, and common salt 200 and 250 pounds per acre were each used on one plat, three plats remaining unfertilized. In the potato experiments the treatment of the plats was very similar. The experiments were inconclusive. The season was very unfavorable and the potatoes suffered from the rot.

Phosphatic fertilizers on wheat (pp. 147–151).—In response to a request from the Salem County board of agriculture, experiments were planned to test the relative value of like amounts of phosphoric acid in the form of boneblack or South Carolina rock, and wheat was selected as the crop. The experiments were carried out on four farms in Salem County and on the college farm. "The farms in Salem County are all underlaid by marl beds." From 6 to 9 tenth-acre plats were used in each experiment. A mixture furnishing 15 pounds of nitrogen and 20 pounds of potash per acre was applied on all the plats. In addition to this, 330 pounds of boneblack (containing 19.62 per cent available phosphoric acid) or 440 pounds of dissolved South Carolina rock (containing 12.49 per cent available phosphoric acid) were applied on all the plats except two or three, which received no phosphate. The yields and financial results are tabulated for each experiment. "The value of crops on those plats fertilized with phosphoric acid from either boneblack or South Carolina rock were practically identical. The widest

difference in value of crops, $2.48 per acre, is shown on the college farm."

ALFALFA, E. B. VOORHEES, M. A. (pp. 153–160).—This is a report for 1889 of the yields of alfalfa sown broadcast and in drills, being a continuation of an experiment commenced in 1887 (see Experiment Station Bulletin No. 2, part I, p. 126). A piece of land 150 by 30 feet was seeded to alfalfa in April, 1887, the seed being sown broadcast on one half at the rate of 30 pounds of seed per acre, and in drills 14 inches apart on the other half at the rate of 15 pounds per acre. The fertilizers were the same for both halves. In 1889 four cuttings of alfalfa were made—May 29, July 5, August 12, and in September. The total yield of green fodder from these four cuttings is given at 22½ tons per acre for the drilled plat, and 24¾ tons for the broadcast plat. The yields are also tabulated for 1887 and 1888, together with the calculated amounts of hay and of nutritive ingredients and the money value of the same, and these averages are compared with the averages for clover and timothy hay.

The crop has increased in yield each year notwithstanding a disease which materially reduced the yields of the third cuts in 1888 and 1889. * * *

The prospect for future crops is also quite as good as at any time since seeding the plats.

Though the broadcast plat produced much larger yields in both 1888 and 1889 than the drilled plat, final comparisons on this point can be properly drawn only when the plats cease to produce profitable yields. * * *

The chemical analysis of samples from the three cuts in 1887 and the four cuts in 1888 showed that there were no decided variations in the composition of the alfalfa from the different cuts or in the different years.

[At the time of the third cutting (August 12) the leaves of] many of the plants were quite yellow (supposed to be due to *Cercospora helvola*) and distinctly spotted with the fungous growth *Phacidium medicaginis*. * * * It is estimated that nearly one half of the plants were attacked at the time of taking the third cut. [Analyses, which are tabulated, of samples of the healthy and the diseased plants with reference to both food and fertilizing ingredients], show wide variations in the different classes of food compounds when brought to the water-free basis, the healthy plant having 10 per cent more fat, 12 per cent more protein, and 18 per cent more fiber than the diseased, while the diseased plant has 11 per cent more carbohydrates and ash than the healthy plant. This difference is more distinctly shown by calculating the nutritive ratio of the digestible compounds. This is found to be for the healthy plant 1:3.28, and for the diseased plant 1:3.83.

The higher percentage of ash in the diseased plant seems to be largely due to differences in percentage of potash [2.58 per cent in the healthy and 3.12 per cent in the diseased plants, water-free].

Alfalfa as a collector of plant food (pp. 159, 160).—The calculated amounts per acre are given of nitrogen, phosphoric acid, and potash contained in the crops of 1887, 1888, and 1889, and the commercial value of the same. It is estimated that these three crops contained 912 pounds of nitrogen, 161 pounds of phosphoric acid, and 934 pounds of potash, valued at $213.44. "There had been applied since the seeding of the crop less than 200 pounds of actual potash. Since alfalfa is a

deep-rooting plant, it is quite likely that large quantities of this element had been secured from the deeper layers of subsoil."

FODDERS AND FEEDS, E. B. VOORHEES, M. A. (pp. 161–177).—A brief discussion is given of the food ingredients of feeding stuffs and of German feeding standards for animals under different conditions. Analyses (with reference to both food and fertilizing ingredients) made at the station during 1889 are recorded in tables for the following feeding stuffs: Horse sorrel, gluten meal, fodder corn, alfalfa, and pasture grass (seven different kinds, as timothy third year after rye, timothy first and second years after wheat, first year's timothy and clover, second year's timothy and alsike clover, mixed seventeenth year, and Raritan River meadow), and of timothy hay harvested in clear weather and that which lay through a continuous rain for 17 days (1) in the swath and (2) in cocks. There is also a compilation of analyses (food and fertilizing ingredients) made at the station, including brewers' grain, corn meal, cotton-seed meal, gluten meal, old and new-process linseed meal, malt sprouts, ground oats, wheat bran, wheat middlings, wheat chaff, clover hay, orchard grass, pasture grass, rye grass, timothy hay, German millet, alfalfa, fodder corn, cornstalks (stover), oat straw, and wheat straw; and a comparison between the food ingredients in 60 pounds of pasture grass and in seven rations "assumed as used in general practice."

EXPERIMENTS WITH DIFFERENT BREEDS OF DAIRY COWS, E. B. VOORHEES, M. A. (pp. 178–186).—A reprint of the accounts of this experiment given in Bulletins Nos. 57 and 61 of the station (see Experiment Station Record, vol. I, pp. 258 and 260).

SORGHUM AND SUGAR MAKING (pp. 187–189).—A statement of the experiments in the field and in the sugarhouse at Rio Grande, New Jersey, during 1889. A severe storm in September so injured the crop that the yield of sugar was materially reduced.

REPORT OF CHEMICAL GEOLOGIST, H. B. PATTON, PH. D. (pp. 191–196).—The first year of the work of the station in the line of soil investigations has been spent in reviewing the work already done in this and other countries, in making a general study of the soils of the State, in collecting typical samples of soil, and in determining the lines of investigation to be immediately undertaken. It has been decided to study the red soils of New Jersey with reference to the relations between the color of the soil and its physical properties and fertility. Questions relating to the flocculation of soils will also be investigated. The method adopted for the preparation of soil samples for chemical and physical analysis is described.

REPORT OF BIOLOGIST, J. NELSON, PH. D. (pp. 197–220).—The biologist of the station is engaged for the most part in investigations relating to the oyster industry. The statistics of this industry in New Jersey were given in the Annual Report of the station for 1888 (see

Experiment Station Bulletin No. 2, part I, p. 136). The present report contains general statements regarding the condition and needs of this industry in the United States, a historical résumé of ostreacultural experiments and methods, and a brief account of experiments by the author in the culture of oysters in a *claire* at Key Port, New Jersey, and in the station laboratory. Most of the work of the year was preparatory and actual experimenting was not begun until late in the season. The laboratory experiment was materially interfered with by the impurity of the water used and the improper construction of the tanks. The author records a discovery that spermatozoa may survive the death of the oyster at least 5 days.

Report of Botanist, B. D. Halsted, D. Sc. (pp. 221–239).—This is for the first 10 months during which the station has had the services of a botanist. A considerable portion of this time was necessarily occupied in preparatory work. The report includes notes on weeds along the same lines as those treated in Bulletin No. 52 of the station (see Experiment Station Record, vol. I, p. 130); explanations regarding the pollen of plants, with a brief account of observations by a number of persons in New Jersey, with reference to the relation between wet weather at the time of the blooming and the setting and maturing of fruit. An outline of the plan of these experiments was given in Special Bulletin C of the station (see Experiment Station Record, vol. I, p. 134). The season of 1889 was very wet and thus unfavorable for such experiments. In the case of apples it was observed that no fruit was set when the flowers were not permitted to get dry. Keeping strawberry vines wet during the time when the fruit is setting is probably undesirable.

Some experiments were made in clipping the lower half of currant clusters. This practice increased the number, size, and weight of the berries as compared with those on untreated bushes. There are also brief notes on potato rot (*Phytophthora infestans*), grape rot, cranberry gall fungus (*Synchytrium vaccinii*), cranberry scald, cucumber mildew (*Peronospora cubensis*), sweet potato rots (*Rhizopus nigricans*, *Ceratocystis fimbriata*) leaf blight on lilac (*Phyllosticta halstedii*), and fungicides. Observations on the two diseases of the cranberry above referred to were reported in Bulletin No. 64 of the station (see Experiment Station Record, vol. I, p. 263). The cucumber mildew was first observed on cucumbers growing under glass, and was afterwards found on pumpkins, squashes, and field cucumbers in various parts of the State.

Report of Entomologist, J. B. Smith (pp. 241–313, figs. 22).—The author assumed the duties of entomologist to the station April 1, 1889. Considerable preliminary work was necessary in securing apparatus and making collections of insects. General information regarding this department was given in Bulletin No. 55 of the station (see Experiment Station Record, vol. I, p. 134). The report contains an account of the horn fly (*Hæmatobia serrata*), taken from Bulletin No. 62 of

the station (see Experiment Station Record, vol. I, p. 260); compiled and original notes on the periodical cicada (*Cicada septendecim*), imported elm leaf beetle (*Galeruca xanthomelæna*), imported elm borer (*Zeuzera pyrina*), clover leaf beetle (*Phytonomus punctatus*), asparagus beetle (*Crioceris asparagi*), grape plume moth (*Oxyptilus periscelidactylus*), grape phymatodes (*Phymatodes amœnus*), codling moth (*Carpocapsa pomonella*), yellow-necked apple tree caterpillar (*Datana ministra*), plum curculio (*Conotrachelus nenuphar*), peach borer (*Sannina exitiosa*), white cabbage butterfly (*Pieris rapæ*), fall webworm (*Hyphantria cunea*), grapevine sawfly (*Selandria vitis*), and cutworms; statements regarding the preparation and use of Paris green, London purple, tobacco, and kerosene emulsion as insecticides; and descriptions of spraying machinery and the powder bellows.

Periodical cicada.—Brood No. 8, as recorded in Bulletin No. 8 of the Division of Entomology of this Department, appeared in New Jersey in 1889, but in such small numbers that they did little or no injury.

Imported elm leaf beetle.—Climax Insect Poison, a preparation of London purple, was successfully sprayed on trees infested with this insect. A mixture of London purple and kerosene emulsion, with and without rye flour, destroyed the eggs.

The larvæ as a rule were observed to come to the base of the trees for pupation. Those that pupated under the bark of the trees were "very generally attacked by a fungus that carried them off by the thousands." The pupæ can be readily destroyed by hot water sprinkled at the base of the tree. The author concludes from his observations that "a single annual brood is the rule in New Jersey, though there may be two in the southern part of the State."

Asparagus beetle.—Kerosene applied in a very fine spray killed a large proportion of the larvæ, but did not injure either the eggs or perfect beetles. London purple, applied at the rate of 1 ounce to 5 gallons of water, was entirely ineffectual. X. O. Dust, applied with a powder bellows, killed fully 90 per cent of all the larvæ. "The beetles were driven off but soon returned, while the eggs were not injured in any way."

White cabbage butterfly.—X. O. Dust, applied with a powder bellows, killed all the larvæ that were touched by it.

APPENDIX (pp. 315–336, plate 1).—This contains the acts of the State legislature relating to the station and to fertilizer inspection; directions for sampling fertilizers and feeding stuffs; the order of station work; a brief description of the station laboratory; and a catalogue of the bulletins of the station from May 17, 1880, to December 31, 1889, inclusive. A list of these bulletins to December 31, 1888, may also be found in Experiment Station Bulletin No. 2, part I, p. 142, and abstracts of the bulletins for 1889 are contained in Experiment Station Record, vol. I.

SECOND ANNUAL REPORT OF NEW JERSEY COLLEGE STATION (pp. 337-342).—This includes a brief account of the organization of the station, and a financial statement for the fiscal year ending June 30, 1889.

New Jersey Stations, Annual Report, 1890 (pp. 585).

REPORTS OF TREASURER (pp. 11 and 555).—An exhibit of the receipts and expenditures of the New Jersey State Station during 1890, and of the New Jersey College Station during the fiscal year ending June 30, 1890.

REPORT OF DIRECTOR (pp. 13-17).—A brief review of the work of the year and a list of the bulletins published during that time. M. E. Gates, LL. D., acting director of the station, resigned October 1, 1890, and J. Neilson was appointed in his stead.

FERTILIZERS (pp. 21-101).—This includes statistics on the amount and value of the fertilizers used in the State during 1890; a comparison of the year's trade with that of each preceding year since 1882; a comparison of the wholesale and retail prices of fertilizing ingredients for the past 3 years; a monthly review of the fluctuations in prices of crude fertilizing materials during the year, together with a summary of the same for each year since 1888; a popular discussion on the sources of nitrogen, phosphoric acid, and potash; a reprint from Bulletins Nos. 66 and 71 of the station (see Experiment Station Record, vol. II, pp. 164 and 280) of articles on the rational use of fertilizers, home-mixing, the composition of incomplete fertilizers, etc.; abstracts from the State fertilizer law; general information concerning the method of collecting samples of the fertilizers sold in the State; schedule of trade values for 1888, 1889, and 1890; and analyses of 314 samples of commercial fertilizers and fertilizing materials, including nitrate of soda, sulphate of ammonia, dried and ground fish, tankage, dried blood, cotton-seed meal, boneblack, bone ash, South Carolina rock, dissolved bone, ground bone, muriate of potash, kainit, sulphate of potash, sylvanit, cotton-hull ashes, ground tobacco stems, wood ashes, precipitated carbonate of lime, marl, wool waste, muck, and buckwheat hulls.

EXPERIMENTS WITH NITRATE OF SODA ON TOMATOES (pp. 102-120).—A reprint of Bulletin No. 79 of the station (see Experiment Station Record, vol. III, p. 30).

EXPERIMENTS WITH FERTILIZERS ON POTATOES (pp. 120-142).—A reprint from Bulletin No. 80 of the station (see Experiment Station Record, vol. III, p. 32).

FIELD EXPERIMENTS WITH FERTILIZERS ON WHEAT (pp. 142-149).—A reprint from Bulletin No. 80 of the station (see Experiment Station Record, vol. III, p. 35).

MISCELLANEOUS FIELD EXPERIMENTS (pp. 149-155).—*Nitrate of soda on timothy grass* (pp. 149, 150).—A trial with timothy on two plats 600 by 33 feet, on one of which nitrate of soda was applied at the rate of 100

pounds and at a cost of $2.25 per acre, the other receiving no nitrate, showed an increase of 590 pounds of dried hay per acre where the nitrate was used. With hay at $12 a ton "the profit from the use of nitrate is $1.29 per acre."

Fertilizers on sweet potatoes (pp. 150–152).—A preliminary experiment on 12 twentieth-acre plats on the farm of G. E. Farry. The fertilizers consisted of nitrate of soda, 160 and 320 pounds per acre, applied all at one time, May 20, or half then and the remainder June 20, both alone and in connection with superphosphate 320 pounds and muriate of potash 160 pounds per acre. One plat received the mixture of superphosphate and potash without nitrogen, another 20 tons of barnyard manure per acre, and two remained unmanured. The soil was very light and sandy. The table of yields shows the yield of merchantable potatoes to have been largest (120 bushels per acre) where barnyard manure was used, and next largest (85 to 90 bushels) where nitrate of soda was used with superphosphate and potash. The double amount (320 pounds) of nitrate of soda seemed to be without benefit to the crop, and where nitrate was used alone there was scarcely any increase of yield over that of the unmanured plats. "The yield of merchantable potatoes was increased over 60 per cent by the use of phosphoric acid and potash" without nitrogen. Allowing 75 cents per bushel for the sweet potatoes, "wherever nitrate was used alone, except on plat 2, there was a loss ranging from 25 cents to $8. There was a profit from the use of mineral elements alone [superphosphate and muriate of potash], and also in every case where the complete fertilizer was used, though not in any case as great as the profit from the barnyard manure when the cost of the manure is rated at $1.50 per ton."

Fertilizers upon peach trees (pp. 153–155).—A report is given for 1890 of the experiments carried on since 1887 on the farm of S. C. Dayton, the general plan of which was referred to in connection with the report for 1889 (see above, p. 293). A summary is given of the results in 1887, 1888, and 1889. The crop in 1890 was "a complete failure."

Another experiment was commenced in 1890 on the farm of S. S. Voorhees, trees being set on 3 fourth-acre plats and corn planted between the rows. The yield of corn is tabulated.

ALFALFA (pp. 156–160).—This is a continuation of the experiment commenced in 1887 (see above, p. 295), being a report of the yield of the drilled and the broadcasted plats in 1890 at four successive cuttings—May 22, June 24, July 30, and September 16. "The total yield of green fodder per acre was 22.7 tons from the drilled plat and 22.45 tons from the broadcasted plat."

The adaptability of this crop was further tested on another piece of land at the college farm and on three other farms in different parts of the State, the seed being broadcasted on plats one fourth to one half an acre in area. The seed and fertilizers were furnished by the station. In every case except at the college the growth of alfalfa after the first

cutting (June) "was so light that the experiment was considered a failure."

FODDERS AND FEEDS (pp. 161–167).—Analyses are tabulated showing the food and fertilizing ingredients of timothy hay, wheat straw, linseed meal, cotton-seed meal, malt sprouts, dried brewers' grains, Buffalo feed, and Chicago feed. There is also a compilation of analyses of various feeding stuffs.

EXPERIMENTS WITH DIFFERENT BREEDS OF DAIRY COWS (pp. 169–230).—A complete record is given of the data obtained in the test of breeds of cows from May, 1889, up to November 2, 1890, when it was prematurely terminated by fire. These data previously appeared in Bulletins Nos. 57, 61, 65, 68, and 77 of the station (see Experiment Station Record, vol. I, pp. 258 and 260, and vol. II, pp. 162, 241, and 499).

REPORT OF CHEMICAL GEOLOGIST, H. B. PATTON, PH. D. (pp. 231–248).—An account of investigations regarding the relation which flocculation in soils bears to their fertility. The samples of the soils investigated were taken according to the method recommended by Professor Hilgard. In every case both soil and subsoil were sampled, the latter, when possible, to a depth of at least 2 feet. The samples examined comprised "trap-rock soils," "Triassic red-shale soils," and a few from "Tertiary soils," and from soils formed by a mixture of the last two kinds. A few samples of clay were also taken for comparison with the clayey soils. Brief descriptive notes are given for each of the samples studied. A mechanical analysis of these soils was first made with reference to the relation, if any, between the size of the soil particles and fertility. The method of analysis used was the "beaker elutriation" method, devised by T. B. Osborne. The results are stated in detail in four tables. It was observed that the amount of organic matter and water in the soil seems to bear little relationship to the fertility. In the case of clayey soils there was a small difference in fertility in favor of the soil with relatively little clay. "It may be noted how very small the amount of clay is in even the heaviest soils," the average percentage of clay being only a little over nine. Sand was found in excess in the good soils, and the finer silt and dust in the poorer soils.

This is especially marked in the red shales and Tertiary soils, but not so much so in the trap-rock soils. The general scarcity of the coarser materials in the latter may account in part for the difference being so little between the good and poor soils. The exceptions to this in individual soils are quite inconsiderable when we consider that no account is taken here of probable differences in chemical composition.

It is well known that the trap-rock soils yield much poorer results on the average than the red-shale soils when under cultivation. During a dry season, however, the former have the advantage as they hold the water better. This experience agrees with the analyses in these two tables. On comparing the two it is seen that the better trap-rock soils contain over 60 per cent of silt and dust, while the better red-shale soils contain but little over 35 per cent of the same.

To study questions relating to the flocculation of soils, settling experiments were made with clays and with soils. "For this purpose beakers 5 cm. in diameter were employed. Five grams of soil or clay were taken, and for the purpose of removing the coarsest sand it was put through a sieve with 0.25 mm. holes. The beakers were then filled with water to a depth of 4 cm. After thorough stirring there was noted (1) the time required for the soil or clay to settle, (2) the condition of the sediment after a given lapse of time." The results are stated in tables. The clays, with the exception of one which more nearly resembled a natural soil in its mechanical composition, were very flocculent and settled rapidly. The sediment remained in a loose mass, which did not become compact and firm even after months' standing. As regards the soils, it was observed that in nearly all cases the subsoil was more flocculent than the surface soil, and that the trap soils were, as a rule, more flocculent than the others examined.

This tendency of the trap-rock soils to flocculate is undoubtedly a redeeming feature, as the good and poor soils belonging to the red shale and Tertiary areas do not appear to show this difference.

It would appear, therefore, that the very fine-grained soils naturally tend to flocculate. What breaks up the floccules at the surface is not so clear, whether the action of the frost or the mechanical action of the plow, or whether it is produced by the action of chemical agents. The effect of free ammonia [used experimentally by the author to break up floccules] would seem to indicate that the last is an effective cause, as free ammonia is generally present in soils. This suggests that the too free use of ammonia-forming fertilizers, as of manure, may very possibly have the effect of rendering the soil heavy by breaking up the floccules. On the other hand, the well-known action of lime on heavy soils is to make the soil light by assisting in the formation of floccules.

Report of Biologist, J. Nelson, Ph. D. (pp. 249–320).—A detailed account of laboratory experiments in ostreaculture by the author in the summer of 1890 at the station, and at Key Port and Oceanic, New Jersey. The report includes a description of the laboratory equipment and of the artificial sea water used; a list of questions in ostreaculture, which the author's experience shows to be proper subjects for investigation; an explanation of the methods of experimenting employed, and of the terms used in the tabulated record; tabulated data for observations on a considerable number of oysters; a calendar giving the dates and the temperature of the air in the laboratory for each set of experiments; a detailed record of experiments with the germ cells of the oyster; tables of the temperature of the water in or near oyster beds at Oceanic, Key Port, and Perth Amboy, New Jersey, for several months, as collated by volunteer observers; a discussion of the experiments, and observations under the following heads: Submarine climate, repetitive spawning, the effects of postmarinal age, viability of the spermatozoa and of the eggs, effect of solutions of different strengths, effect of temperature and saltness, dispersal of spawn, optimal saltness, acceleration of development, parasites, "mudding" of oysters, spawning oysters as food,

legal aspects of the oyster trade, technical problems, and miscellaneous. Tables are also given showing the viability of the spermatozoa in different solutions of sea water; effect of strength of solution and age of the oyster on the character of the development; influence of temperature, etc., on the rate of development of the oyster's eggs; factors affecting the viability of the eggs of the oyster; effects of age, etc., on the eggs. The following summary of the conclusions reached from a study of the summer's records is taken from the report:

Temperature and spawning.—(1) From the latter part of April until June, the temperature of the water upon the oyster beds at Perth Amboy, Key Port, and Oceanic rose steadily from about 50° F. until it reached 70°, June 1, in the Shrewsbury River, and about the middle of June in Raritan Bay.

(2) From this time on during the spawning season the temperature fluctuated between 70° and 80° F.

(3) Spawning began upon the respective beds very soon after the temperature reached the seventies.

(4) Seed obtained from the more northerly beds spawned first, and finished spawning relatively early.

(5) Seed from the Chesapeake region spawned later, and was the last to show spawn.

(6) The supposed evidence for the belief that the same oyster may repeat the spawning process more than once in a season was found insufficient.

(7) No oysters were found in which all the eggs were capable of developing. (Perhaps 70 per cent represents the most fruitful result obtained.)

(8) Seed which matures its sexual cells early produces more fruitful results in vigor and relative number of offspring than the later spawners of the same kind ot seed.

(9) At Key Port after August 7 the spawning proper had ceased; only young Southern plants showed traces of spawn after this date.

Physiology of oysters.—(10) Oysters removed from the water and left dry at ordinary summer temperatures remain closed for about a week.

(11) When oysters begin to fail in the power of holding the shell closed they are not dead, for a stimulus will cause closure for a short time.

(12) Such oysters are partially spoiled, through fermentative action of bacteria, and are unfit for food.

(13) After this point of weakness is reached the death of the oyster is rapid. One day later it fails to respond to stimulation.

(14) Freshening oysters increases very rapidly the rate of weakening and decay of oysters. (The life period is reduced one half.)

(15) After an oyster is opened the death is rapid and in proportion to the length of time the oyster has been out of the water.

(16) If oysters be placed in limited supplies of sea water the postmarine life period is not lengthened, owing to the breeding of infusoria and bacteria in the water.

(17) Oysters open and shut their shells according to a rythmic or automatic law (while "breathing").

(18) Oysters differ greatly in the rapidity of this rythm of respiration (the object of which is to clear the external gill or mantle cavity of mud).

Parasites.—(19) Several species of infusoria are parasitic in the stomach, etc., of the oyster, but are not abundant enough to be taken account of in culinary interests.

(20) During the early portion of the spawning season there is abundantly present in a large proportion of oysters an infusorial parasite (average length $\frac{1}{800}$ inch), termed by us "cytohelminth" (wormlike cells). [Reference is made to an article by J. Ryder in *Science*, vol. 1, p. 567, containing a description of a parasite, named

by Ryder *Spirillum ostrearum*, and supposed to be the *Trypanosoma balbiani* of Certes. The author of this report believes that this is identical with the cytohelminth observed by him, and that until its life history is better known it can not be assigned to any particular genus and species.]

(21) These cytohelminths are bred in a structure which is or resembles the "crystalline rod," a flexible, gelatinous structure, shaped like a nematode worm, about an inch long, and situated in a loop of the intestine known as the "pyloric" portion.

Oyster economics.—(22) Oysters that are ready to spawn, if cooked soon after removal from the sea bed, are extra good and palatable food.

(23) Oysters in spawn deteriorate more rapidly than at any other season, at the same temperature.

(24) The warmth of summer acts upon oysters as upon other meats, especially fish, to produce rapid decay.

(25) Oysters in market should be under stringent inspection.

(26) Oystermen should not be required to freshen oysters; this should be done by the caterer just before cooking or serving.

(27) Oystermen should not be hampered by laws limiting the time or manner of taking or selling oysters.

The spermatozoa.—(28) Spermatozoa removed from a ripe male oyster and infused into sea water, begin a very active dancing motion either at once or after a "latent period" of a few minutes.

(29) The length of time an oyster has been out of water often determines whether a latent period is present. (Postmarine age in proportion to its length tends to produce this period.)

(30) The spermatozoa survive the death of the oyster for a period inversely proportional to the length of time which has elapsed between the taking of the oyster from its bed and the artificial opening of the same.

(31) The activity of the spermatozoa lasts during a period the length of which depends on whether a latent period is present or not, the postmarine age of the oyster, the density of the water, the temperature, the presence or absence of eggs, the age of the eggs if present, and whether the oyster has been freshened or not.

(32) Oysters with latent period have spermatozoa with decreased periods of activity.

(33) Fresh spermatozoa in their native sea water are active over 5 hours.

(34) This period is shortened in proportion to the postmarine age, in which (*a*) the number of days before the oyster is opened count as nearly equal in influence to (*b*) those that have elapsed since the oyster was opened. (By the end of a week the period is reduced to a quarter of an hour, but (*c*) conditions of temperature and moisture affect the result. The above experiments were performed upon oysters subjected to an average of 75° F., and moderately shielded from evaporation after opening.)

(35) Densities of salt water above 2 per cent shorten the active period to about a quarter of an hour, when 3½ per cent is reached.

(36) Densities weaker than 1⅜ per cent (or thereabouts) shorten the period to the same extent when one fourth per cent is reached.

(37) Postmarine age tends to shift the optimum strength of solution up the scale. For oysters nearly a week old the optimum is above 3 per cent instead of being below 2 per cent, as for fresh spermatozoa.

(38) Increase of temperature increases the activity but shortens the period. The practical limit (a period of a few minutes duration) is reached between 100° and 110° F.

(39) The optimum temperature for spermatozoid activity lies, roughly estimated, at 85°. (Lower limits not yet ascertained.)

(40) When spermatozoa are infused into water containing eggs their activity is increased, but the period is shorted one half.

(41) The fresher the eggs the greater their effect in shortening this period, but the two parts of postmarine age, viz, the days before opening and the days after opening, have unequal influence. Days after opening have less effect to shorten the period than days before opening.

(42) Freshening of oysters reduces the vitality of spermatozoa.

(43) The ability of spermatozoa to fertilize eggs decreases with postmarine age, and after 2 or 3 days the results are no longer satisfactory, although development is caused for some time later, yet this development shows a gradually descending scale of power as age increases.

(44) In 2 or 3 days the active period of spermatozoa is reduced one half; it follows that spermatozoa can suffer a weakening of 50 per cent of their vitality before losing the power to cause at least fair results in fertilization and development.

The eggs.—(45) Eggs are, at every point where environment influences them, more sensitive than spermatozoa.

(46) Eggs do not survive the death of the oyster unless the oyster be opened fresh.

(47) In oysters over 2 days old the eggs fail to produce embryos but rapidly decompose in the sea water (oyster still alive).

(48) Fresh eggs, unfertilized, remain in sea water for several days before yielding to decomposing forces.

(49) In solutions weaker than normal and in proportion to the dilution, fresh eggs decompose rapidly, passing through stages of swelling.

(50) In solutions stronger than normal, fresh eggs shrink, and finally also decompose with rapidity.

(60) Freshening of oysters acts very strongly to produce deterioration of eggs. Sometimes the eggs are as far gone when the oyster is first received as if the oyster (unfreshened) had been kept over 2 days.

(61) Eggs in oysters of only 1 day's postmarine age show (*a*) a great decrease in the number of eggs fertilizable, and (*b*) a partial and abortive development.

(62) Fresh eggs can remain in normal sea water over an hour before fertilization without losing the power of being fertilized and of developing.

(63) Some partial and abnormal development takes place even after 2¼ hours' soaking before fertilization.

(64) Solutions weaker or stronger than normal (*a*) decrease the period eggs can remain unfertilized without deterioration, or (*b*) if the period be the same, the results in development are correspondingly unsatisfactory, poor, or *nil*.

(65) Temperatures favorable to development range from 70° to 100°, with a probable optimum near 85° F.

(66) Increase in temperature rapidly increases the rate of development by about double for every 10°.

Embryos.—(67) Embryos can not be readily kept to the time of fixation without the assistance of a *claire* to furnish food.

(68) Embryos seem to be attacked by the infusorial parasites from the stomach, etc., of the adult oyster.

(69) At average temperatures vigorous embryos are all at the surface from one half to three quarters, or 1 day, and can be readily separated from débris and sediment at such time.

(70) Many embryos fail to become free-swimming.

(71) No satisfactory way of separating good eggs from bad ones in oyster culture was discovered.

(72) Eggs sink in sea water at a rate of nearly 1 foot per hour. (This can be taken advantage of in cleaning eggs by stratification.)

(73) Spawn is dispersed mainly by tidal currents during the short period the embryo swims at the surface.

(74) (*a*) The temperature of the water at Key Port was favorable to a set as judged by our records and experiments, and (*b*) a set was reported to have occurred—the first for many years.

(75) The saltness of the water at Key Port is close to the upper extreme of density for oyster culture, and can be weakened to 1.5 per cent, if not lower, without producing any unfavorable results so far as a "set" is concerned.

(76) Embryos are more delicate than their infusorial enemies.

(77) Embryos do not stand a sudden transfer into water weaker or stronger than 1½ to 2 per cent without being greatly weakened.

REPORT OF BOTANIST, B. D. HALSTED, D. SC. (pp. 321–453, plates 24, fig. 6).—This includes an investigation of the causes of the failure of the peach crop in 1890, the effect of wet weather at the time of blooming on the setting of fruit, notes on fungous diseases, and a list of weeds of the State.

Observations in peach orchards (pp. 323–327).—A list of questions addressed to peach growers in the State is given from Special Bulletin L of the station (see Experiment Station Record, vol. II, p. 501), together with a summary of the replies received. In many cases the answers show great variety of opinion and practice, though in the following cases there was a much nearer approximation to unanimity: (1) In nearly all instances the peach orchard was naturally well drained; (2) the average tillage of the peach orchard is about 3 years of hoed crop or buckwheat one season, and afterward clean culture; (3) The majority of the orchards were without forest or other protection; (4) "fully 75 varieties are named, of which Smock, Crawford Late, Reeves, Pride of Franklin, Selway, Morris Rare Ripe, Old Mixon, President, and Mountain Rose are among those most generally grown"; (5) "as a rule the injury did not extend beyond the buds, but in some cases the upper ends of the branches suffered"; (6) age did not make constant difference as regards amount of injury; (7) "it was generally agreed that the excessive autumn rains, warm winter, cold snap on March 5 to 8, and frosts of April 18 were the chief reasons which combined to ruin the peach crop the past season."

Microscopic study of peach buds (pp. 327–330).—Notes and illustrations are given to show the normal condition of the dormant peach bud in winter, and of the buds as prematurely developed by warm weather and afterwards as injured by the cold.

Influence of rainfall at blooming time upon subsequent fruitfulness (pp. 330–332).—Brief notes are given on experiments in continuation of those recorded in the Annual Report of the station for 1889 (see above, p. 297). Strawberries kept constantly wet by frequent sprinkling during the time of flowering produced fewer and more irregular berries than adjacent plants that were not sprinkled. Plants covered by canvas also set fewer berries than those left uncovered. The flowers on an apple tree kept wet by spraying failed to set fruit, although surrounding trees of the same kind which were dry produced a full crop.

Experiments on cranberry diseases (pp. 332–339).—As the result of

investigations reported in Bulletin No. 64 of the station (see Experiment Station Record, vol. I, p. 263) on the cranberry gall fungus (*Synchytrium vaccinii*), an act was passed by the State legislature authorizing the officers of the station to enter upon any lands bearing vines or plants affected with injurious fungous growths and destroy the same by fire or otherwise. The full text of this act is given in the report. The bog in which the gall fungus was discovered was treated by withholding the water from the bog during the winter. This had a good effect, although in those parts of the bog which could not be kept dry the gall fungus was present in great abundance.

Several experiments with fungicides, including sulphate of copper, sulphate of iron, flowers of sulphur, and lime are reported, but no decisive results were obtained. Experiments by J. P. Goldsmith in covering bogs infected with the scald with earth to the depth of about an inch, have indicated that this method of treatment will materially decrease the ravages of the scald.

Fungous diseases of the sweet potato (pp. 339–345).—A reprint of the concluding paragraphs of Bulletin No. 76 of the station (see Experiment Station Record, vol. II, p. 416). Field experiments with flowers of sulphur, sulphate of copper, air-slaked lime, gas lime, common salt, and carbonate of lime for the soil and black rots of sweet potatoes, were conducted by several growers, but without decisive results.

Fungous diseases of various crops (pp. 345–366).—This includes notes on the fungous diseases which injured variousfield crops in the State in 1890, as follows: *Potatoes.*—Potato rot (*Phytophthora infestans*), a disease thought to be due to bacteria, and potato scab. *Cabbages.*—Club root (*Plasmodophora brassicæ*), a mildew (*Peronospora parasitica*), and black mold (*Macrosporium brassicæ*). *Radishes.*—Club root (*Plasmodophora brassicæ*) and white mold (*Cystopus candidus*). *Turnips and carrots.*—A root rot caused by an undetermined fungus. *Salsify.*—A root rot due to bacteria, which also injured turnips, carrots, and onions. *Onions.*—A botrytis (probably *Botrytis parasitica*), onion smut (*Urocystis cepulæ*), onion vermicularia (*Vermicularia circinans*), and black mold (*Macrosporium* sp.). *Spinach.*—Besides the species of fungi referred to in Bulletin No. 70 of the station (see Experiment Station Record, vol. II, p. 241), a leaf blight (*Cercospora flagilliformis*, E. & Hals.). *Eggplants.*—Leaf spot (*Phyllosticta hortorum*), ashy mold (*Botrytis fasicularis*), and anthracnose (*Glœosporium melongenæ*, E. & Hals.). *Peppers.*—Two species of anthracnose (*Glœosporium piperitum* and *Colletotrichum nigrum*, E. & Hals.) and a leaf spot (*Phyllosticta*). *Horse-radish.*—A leaf spot (*Septoria armoraceæ*) and a white mold (*Ramularia armoraceæ*). *Hollyhock.*—Rust (*Puccinia malvacearum*), leaf spot (*Cercospora althæina*), and *Colletotrichum malvarum*. *Violets.*—Leaf spot (*Cercospora violæ*), *Phyllosticta violæ*, a mildew (*Peronospora violæ*), anthracnose (*Glœosporium violæ*), and a white mold (*Zygodesmus albidus*, E. & Hals.). A number of other diseases of the violet were observed, and the whole

subject will be treated in a future bulletin. *Carnations.—Septoria dianthæ* and *Vermicularia subeffigurata*. *Mignonette.—Cercospora residæ*. *Plum and cherry trees.*—Black knot. A brief summary of information, which was given in more detail in Bulletin No. 78 of the station (see Experiment Station Record, vol. II, p. 501).

Fungicide and insecticide combined.—A brief account of successful experiments by J. M. White with Climax Insect Poison (a preparation of London purple and starch) and ammoniacal carbonate of copper for the codling moth and fungous diseases of pears, apples, and grapes.

Nematodes as enemies to plants (pp. 366–370).—Nematodes were observed in the roots of violets, oats, and roses, and upon the leaves of chrysanthemums, coleus, lantana, and bouvardia. Specimens of the nematodes attacking the leaves of the above-mentioned plants were submitted to G. F. Atkinson of the Alabama College Station, who reports that they are probably of the same species, for which he proposes the name of *Aphelenchus foliicoleus*.

Weeds of New Jersey (pp. 370–453).—An explanation of the scale of points for grading weeds according to their harmfulness, which is proposed by the author in Bulletin No. 52 of the station (see Experiment Station Record, vol. I, p. 130); lists of 20 or more of the worst weeds of New Jersey, in the order of their vileness, by fourteen different observers in the State, with partial lists by five other persons; an article on the weeds of Sussex County, New Jersey, by T. Lawrence and W. M. Van Sickle; and a preliminary classified list of 265 species of weeds found in New Jersey, with an index to their common names. Twenty-four of the leading kinds of weeds of the United States are described and illustrated in plates taken from the annual reports of this Department. The 30 worst weeds of New Jersey in the order of their vileness, as determined from the reports of the observers above referred to, are as follows: Wild carrot (*Daucus carota*), ox-eye daisy (*Chrysanthemum Leucanthemum*), sorrel (*Rumex acetosella*), plantain (*Plantago major*), curled dock (*Rumex crispus*), ragweed (*Ambrosia artemisiæfolia*), Canada thistle (*Cnicus arvensis*), purslane (*Portulaca oleracea*), burdock (*Arctium lappa*), toadflax (*Linaria vulgaris*), wild onion (*Allium vineale*), mayweed (*Anthemus cotula*), goosefoot (*Chenopodium album*), yellow daisy (*Rudbeckia hirta*), pigweed (*Amarantus chlorostachys*), quitch grass (*Agropyrum repens*), horseweed (*Erigeron canadensis*), beggar's ticks (*Bidens frondosa*), water pepper (*Polygonum hydropiper*), shepherd's purse (*Capsella bursa-pastoris*), pepper grass (*Lepidium virginicum*), rib grass (*Plantago lanceolata*), milkweed (*Asclepias syriaca*), dandelion (*Taraxacum officinale*), burr grass (*Cenchrus tribuloides*), corn cockle (*Lychnis githago*), velvet leaf (*Abutilon avicennæ*), thistle (*Cnicus lanceolatus*), chickweed (*Stellaria media*), black mustard (*Brassica nigra*). Of the 265 species of New Jersey weeds 135 are native and 130 have been introduced from abroad; but of the 20 worst weeds only 4 are native. As to length of life, the distribution of the species is as follows:

Annuals 105, biennials 34, and perennials 126. The following table shows the distribution "according to the somewhat arbitrary scale of worst, bad, and indifferent weeds":

	Annuals.	Biennials.	Perennials.	Total.
Worst weeds	30	7	17	54
Bad weeds	44	15	39	98
Indifferent weeds	31	12	70	113
Total	105	34	126	265

REPORT OF ENTOMOLOGIST, J. B. SMITH (pp. 455–528, figs. 30).—This contains brief general notes on the work of the year; an abstract of an article on insecticides and their use, published in Bulletin No. 75 of the station (see Experiment Station Record, vol. II, p. 415); compiled notes on the following insects affecting sweet potatoes, with suggestions as to remedies: Two-striped sweet potato beetle (*Cassida bivittata*), golden tortoise beetle (*Coptocycla aurichalcea*), mottled tortoise beetle (*Coptocycla guttata*), and black-legged tortoise beetle (*Cassida nigripes*); original and compiled notes on the squash borer (*Melittia ceto*), striped cucumber beetle (*Diabrotica vittata*), boreal ladybird (*Epilachna borealis*), and melon aphid (*Aphis cucumeris*) as insects injurious to squash and melon vines; eight-spotted forester (*Alypia 8-maculata*) as injurious to the grape; katydid (*Microcentrus retinervis*) and tip worm as injurious to cranberries; black peach aphis (*Aphis persicæ-niger*) and peach borer (*Sannina exitiosa*) as injurious to peach trees; wheat louse (*Siphonophora avenæ*), white cabbage butterfly (*Pieris rapæ*), elm leaf beetle, curculio, apple borer, army worm, corn worm, and clover leaf beetle (*Phytonomus punctatus*).

Special Bulletin K of the station (see Experiment Station Record, vol. II, p. 418) gave an account of a number of insects injurious to cranberries in 1889. In 1890 unusual injury was done to cranberries by katydids. Experiments in cranberry bogs at Jamesburg, New Jersey, indicated that drawing the water from the bogs in the spring and afterwards letting it on again would do much towards preventing the ravages of these insects. Spraying infested patches of the bogs with London purple and Paris green was found to be decidedly beneficial. But "to make spraying successful against these cranberry pests, it is necessary to make the application just as soon as they are hatched and before they get the leaves webbed up." Experiments by the author prove, in his judgment, that punctures by the curculio will not cause the dropping of apples; that though the eggs may hatch, the larvæ will not develop in growing apples; that a decaying condition is necessary to bring them to maturity; and that they will not develop in withered fruit when no decay is started. This result enforces the necessity of clearing the orchards of fallen fruit, and especially early in the season.

APPENDIX (pp. 529–549).—This contains the acts of the State legislature relating to the station, to the prevention of the spread of fungous diseases of plants, and to the inspection of fertilizers; directions for sampling fertilizers and feeding stuffs; the order of station work during the year; and a catalogue of the bulletins issued by the station from its organization (1880) to December 31, 1890. Abstracts of the bulletins for 1889 and 1890 may be found in Experiment Station Record, vols. I and II.

THIRD ANNUAL REPORT OF THE NEW JERSEY COLLEGE STATION FOR THE YEAR ENDING JUNE 30, 1890 (pp. 551–556).—This contains a brief statement as to the organization of the station.

New Jersey Stations, Bulletin No. 83, September 15, 1891 (pp. 35).

ANALYSES AND VALUATION OF FERTILIZERS, E. B. VOORHEES, M. A.—This contains analyses of 212 brands of "complete fertilizers" collected within the State during 1891. These analyses "furnish direct answers to the following questions:"

(1) Do the analyses of fertilizers give any definite information as to the kind of materials used in making the different brands?

(2) In the number of brands on the market, is there a variation in composition sufficient to fulfill special soil and crop requirements?

(3) Do the manufacturers as a rule furnish in their mixtures the amount of plant food claimed in the guaranties?

(4) When a given brand is found to give satisfaction is there any evidence that it will not change in composition from year to year?

(5) Are the station's valuations of the different brands of any value as a guide in their purchase?

(6) Is it more advantageous to buy high-grade than low-grade fertilizers?

It is claimed that while the analysis does not furnish complete information as to the source and quality of the materials entering into the composition of a compound fertilizer, "an analysis, rightly interpreted, may be of great service in the selection of the most efficient brands." Wide differences were found in the composition of special crop fertilizers prepared by different manufacturers.

For instance, there are 11 different brands for potatoes, varying widely in composition both as regards quantity and quality of plant food. A tabulation of these brands shows that the nitrogen varies from 0.76 to 5.33 per cent, available phosphoric acid from 2.61 to 9.77 per cent, and potash from 2.09 to 12.22 per cent. This would seem to indicate either that manufacturers are not a unit as to their ideas of the special requirements of the potato, or that no particular significance should be attached to special-crop brands as now prepared by the different manufacturers.

With regard to the relation between the guaranty and the results of analysis, 114 (54 per cent) of the 212 brands analyzed were found to be below the guaranty with respect to one or more ingredients. This leads the author to conclude that "the guaranty is not a safe guide as to the composition of more than one half of the brands on the market in the State." However, "a careful study of the published analyses of

fertilizers is valuable in that it shows which of the manufacturers sell in a mixture at least as much of the valuable ingredients as they claim." By a comparison of the analyses of the brands of three large firms for the past 5 years it was found that "the composition is practically constant both in regard to proportion and amount of plant food contained."

Of the 212 brands reported on, the selling price of 2 was below the station's valuation; that of 128, or 60 per cent of the whole, was from 26 cents to $10 greater than the station's valuation; that of 65, or 31 per cent, was from $10 to $15 greater; that of 14 was from $15 to $20 greater; and that of 2 was more than $20 per ton greater.

The station's valuations are of great service in the purchase of mixed fertilizers, when used in connection with the information given by analyses.

[The difference is pointed out between high-grade and low-grade fertilizers.]

The advantages to be derived from the use of high-grade fertilizers are, (1) a direct saving in cost per pound of the actual fertilizing ingredients; and (2) a reasonable certainty that the quality of the ingredients is such as to produce their full agricultural effect.

New York State Station, Bulletin No 33 (New Series), July, 1891 (pp. 23).

FERTILIZERS, P. COLLIER, PH. D. (pp. 533–553).—This is a continuation of the popular bulletins published by the station, and contains an explanation of the terms of chemical analysis, remarks on commercial valuation of fertilizers, a tabulated statement of the composition of various chemical compounds, schedule of trade values of fertilizing ingredients for 1891, and analyses of 30 samples of commercial fertilizers collected within the State during 1891.

New York State Station, Bulletin No. 34 (New Series), August, 1891 (pp. 48)

COMPARISON OF DAIRY BREEDS OF CATTLE WITH REFERENCE TO PRODUCTION OF BUTTER, P. COLLIER PH. D. (pp. 557–602).—This bulletin is a continuation of Bulletins Nos. 18 and 21 of the station (see Experiment Station Record, vol. I, p. 269, and vol. II, p. 243), and is the beginning of the record of milk production in the test of different breeds, the two previous bulletins having been occupied with a description of the cows, fluctuations in live weight, amounts of food consumed, etc. The record includes for the first 6 months of the period of lactation of each cow the amount of fat in 100 pounds of milk, and the proportion of this occurring in cream, skim milk, buttermilk, and in the butter; data as to the fat recovered and lost; the relations of milk, cream, and butter; the daily yields of milk and of butter; the monthly yields of dairy products; the temperature and time of churning; and the relative number and size of fat globules. In addition to these data a summary is given for the cows of each breed, from which the following is taken:

Tabulated summary of results for the first 6 months of lactation.

	Ayrshires.	Guernseys.	Holdernesses.	Holsteins.	Jerseys.
Pounds of fat in 100 pounds of milk	3.50	5.07	3.69	3.71	5.61
Pounds of fat in skim milk from 100 pounds of milk	0.38	0.23	0.44	0.85	0.38
Pounds of fat in cream from 100 pounds of milk	3.12	4.84	3.25	2.86	5.24
Pounds of fat in buttermilk from 100 pounds of milk	0.09	0.05	0.06	0.16	0.08
Pounds of butter from 100 pounds of milk	3.47	5.54	3.64	2.78	5.78
Per cent of fat in milk recovered in cream	89.4	95.50	88.00	75.70	93.40
Per cent of fat in milk lost in skim milk	10.6	4.50	12.00	24.30	6.60
Per cent of fat in milk lost in buttermilk	2.4	0.70	1.50	5.30	1.50
Per cent of fat in milk recovered in butter	84.8	92.50	84.00	64.30	87.60
Pounds of milk required to make 1 pound of butter	29.4	18.40	28.20	40.00	17.50
Pounds of milk required to make 1 pound of cream	5.28	3.73	5.57	7.89	4.01
Pounds of cream required to make 1 pound of butter	4.73	4.96	5.81	5.05	4.45
Per cent of fat in cream	19.50	18.08	18.05	20.47	21.05
Pounds of milk produced per day	19.7	16.50	15.70	27.10	16.40
Pounds of butter produced per day	0.71	0.90	0.56	0.70	0.91
Time of churning (in minutes)	33	30	67	65	51
Relative size of fat globules	536	863	498	523	1087

Although no general conclusions are yet reached, several points of interest seem to have been indicated by the results.

Observations.—While in the foregoing table the largest amount of fat in the milk produces the largest amount of butter, it does not hold good that the amount of butter is, in every case, proportional to the amount of fat in the milk. While the amount of fat in the milk of the Holsteins stands third, the amount of butter stands fifth. The amount of butter produced from 100 pounds of milk depends upon the amount of fat lost in skim milk and buttermilk, as well as upon the amount of fat originally in the milk. * * * While the Jersey milk contains a larger amount of fat and makes a larger amount of butter than the milk of the Guernseys, we see from this table that the Guernseys lost a smaller proportion of fat in both skim milk and buttermilk than did the Jerseys; that is, the creaming and churning efficiency is greater in the case of Guernseys, or, we may say, the Guernseys make relatively more of the fat in their milk, in so far as the results at hand indicate. The amount of fat in the milk of the Ayrshires was lowest, while in creaming and churning efficiency the Ayrshires stand third. * * * As the period of lactation advances the creaming and churning efficiency seems to diminish, that is a larger proportion of fat is lost in skim milk and buttermilk. It remains to be seen how fully our future data will confirm this. * * *

One curious result, which does not seem to agree with the observations of others and which may be changed by more extended observations, is that the amount of fat in the cream does not seem to be in most cases related to the amount of fat in the milk. Thus in richness of milk the order is, (1) Jerseys, (2) Guernseys, (3) Holsteins, (4) Holdernesses, (5) Ayrshires; while in richness of cream the order is, (1) Jerseys, (2) Holsteins, (3) Ayrshires, (4) Guernseys, (5) Holdernesses. * * *

While the average temperature of churning does not vary greatly for the different breeds, the time of churning varies from 30 to 67 minutes. The advance of the period of lactation appears from the data at hand to be accompanied by a higher degree of temperature of churning. * * * There appears to be a general relation between the relative number of fat globules and the creaming and churning efficiency, the milk containing the smaller number being more efficient for butter making. In regard to the relative size of the fat globules, the larger the size the more efficient the creaming and churning. * * *

So far as we can judge from the data now on hand, advance of the period of lactation seems to be accompanied by an increase in the number and a diminution in the size of the fat globules.

New York State Station, Bulletin No. 35 (New Series), August, 1891 (pp. 27).

SOME OF THE MOST COMMON FUNGI AND INSECTS, WITH PREVENTIVES (pp. 603–627).—Popular notes on the following fungi and insects, with suggestions as to remedies: Anthracnose of grapes (*Sphaceloma ampelinum*), apple scab (*Fusicladium dendriticum*), pear scab (*F. pyrinum*), black knot of plum and cherry (*Plowrightia morbosa*), black rot of grapes (*Læstadia bidwellii*), downy mildew (*Peronospora viticola*), powdery mildew of grapes (*Uncinula spiralis*), grape leaf blight (*Cercospora viticola*), white rot and bitter rot of grapes, strawberry leaf blight (*Ramularia tulasnei*), orange rust and anthracnose of the raspberry (*Glœosporium necator*), flat-headed apple tree borer (*Chrysobothris femorata*), round-headed apple tree borer (*Saperda candida*), oyster-shell bark louse (*Mytilaspis pomorum*), apple tree tent caterpillar (*Clisiocampa americana*), forest tent caterpillar (*C. disstria*), yellow-necked apple tree caterpillar, red-humped apple tree caterpillar, fall webworm (*Hyphantria cunea*), cankerworm (*Anisopteryx vernata*), leaf rollers and folders, bud worms, apple tree bucculatrix (*Bucculatrix pomifoliella*), apple tree aphis (*Aphis mali*), apple curculio (*Anthonomus 4-gibbus*), apple maggot (*Trypeta pomonella*), codling moth (*Carpocapsa pomonella*), plum curculio (*Conotrachelus nenuphar*), quince curculio (*C. cratægi*), peach tree borer (*Sannina exitiosa*), strawberry root borer, strawberry crown borer (*Tyloderma fragariæ*), raspberry root borer (*Bembecia marginata*), raspberry cane borer, tree cricket (*Œcanthus niveus*), imported currant borer, American currant borer (*Pristiphora grossularia*), imported currant worm (*Nematus ventricosus*), and currant worm.

New York State Station, Bulletin No. 36 (New Series), September, 1891 (pp. 20).

SMALL FRUITS (pp. 629–646).—Notes on strawberries, raspberries, blackberries, currants, and gooseberries, with brief accounts of their insect and fungus enemies.

Strawberries (pp. 631–639).—Brief descriptive notes on 40 varieties, accounts of the strawberry root borer, crown borer, and leaf blight, with suggestions as to remedies, and a list of the 26 most productive varieties at the station in 1891.

We should advise, if planting for a fancy market, the following varieties: *Early.*—Haverland and Van Deman. *Medium.*—Bubach, Sharpless, and Burt. *Late.*—Crawford, Middlefield, Parker Earle, and Gandy. For a distant market, Van Deman, Stayman No. 1, and Burt. For a near-by market the last-mentioned varieties, with the addition of Beder Wood, Parker Earle, and possibly Mount Vernon. * * *

In 1891 the matted rows of Burt yielded at the rate per acre of 11,344 quarts; Beder Wood, 10,890; Greenville, 8,394; Parker Earle, 8,168.

Raspberries (pp. 639–642).—Brief descriptive notes on 6 of the newer varieties, and accounts of the blackcap orange rust, anthracnose, raspberry root borer, raspberry cane borer, and tree cricket, with

suggestions as to remedies. The Bordeaux mixture is being used at the station for the anthracnose with apparently beneficial results.

The earliest blackcap was the Carman, the latest the Ada, the most productive the Hilborn, with Smith Prolific next.

Of the red varieties, the earliest were Clark and Thompson Early Pride; the latest, Parry No. 2 and Miller Woodland; the most productive, Cuthbert [a fine shipping berry, which can be widely grown], Muskingum, Shaffer [especially recommended for canning], Clark, Thompson Early Pride, Stayman No. 5, Shaffer Pomona, and Genesee, in the order named.

The Caroline, an extremely hardy yellow variety, yielded more than any of the other varieties this year, and the Golden Queen (a yellow Cuthbert) gave also a large yield. Both of these varieties are of superb flavor but soft, and easily damaged because of their color. However they should be in every private collection.

Blackberries (pp. 642, 643).—Of the varieties tested at the station, Agawam, Erie, and Snyder are especially commended.

Currants (pp. 643, 644).—Fay Prolific (on light soils), Cherry, and Prince Albert (late) red varieties, and White Grape are excellent standard varieties. Brief mention is made of the imported currant borer, American currant borer, imported currant worm, American sawfly, and current spanworm, with suggestions as to remedies.

Gooseberries (pp. 644–646).—The foreign varieties, such as Industry, Triumph, Wellington Glory, and Roesch Seedling, grown at the station in 1891, kept entirely free from mildew, and bore an average of over 10 pounds of fruit per plant. During the past 3 years potassium sulphide (one half ounce to 1 gallon of water) sprayed at intervals of 18 to 20 days from the time the leaves began to unfold, prevented the development of mildew.

North Carolina Station, Bulletin No. 79, July 20, 1891 (pp. 22).

FACTS FOR FARMERS, W. F. MASSEY, C. E.—This, as the author states, is "a bulletin of information on scientific matters in plain language for unscientific readers," and treats of the underlying principles of plant growth and plant nutrition, manures, sources of fertilizing materials, etc.

North Carolina Station, Bulletin No. 79*a* (Meteorological Bulletins Nos. 21 and 22), August 15, 1891 (pp. 34).

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, JUNE AND JULY, 1891, H. B. BATTLE, PH. D., AND C. F. VON HERRMANN.—Notes on the weather, monthly summaries, and tabulated daily record of meteorological observations by the North Carolina weather service. The bulletin is illustrated with maps of North Carolina showing the isothermal lines and the total precipitation at the stations in different parts of the State.

Ohio Station, Bulletin Vol. IV, No. 5 (Second Series), September 1, 1891 (pp. 18).

THE WHEAT MIDGE, F. M. WEBSTER (pp. 99–114, figs. 14).—A history of the observations on the wheat midge (*Diplosis tritici*), with transcripts of notes on the ravages of this insect in Ohio each year from 1847 to 1878, inclusive, taken from the reports of the State board of agriculture. Larvæ thought to belong to this species were observed under the sheaths of young plants. Adults were reared from the heads of rye in July and from Volunteer wheat from September 1 to November 3. The figures illustrating the bulletin are after Fitch.

Rhode Island Station, Bulletin No. 11, June, 1891 (pp. 18).

STATE FERTILIZER LAW, COMMERCIAL VALUE OF FERTILIZER STOCK, AND ANALYSES OF COMMERCIAL FERTILIZERS AND MISCELLANEOUS MATERIALS, H. J. WHEELER, PH. D. (pp. 131–146).—This includes analyses of twelve brands of commercial fertilizers, fresh horse manure, street sweepings from the city of Providence, meadow muck, wood ashes, waste liquid from a rendering establishment, and spring water; the schedule of trade values of fertilizing ingredients for 1891; remarks on the valuation of fertilizers; the text of the State fertilizer law; and a copy of a proposition made by the station to the State board of agriculture to make all analyses of commercial fertilizers and wood ashes called for by the fertilizer law, and to compile and publish the same. This proposition was accepted by the State board of agriculture, but at so late a date as to somewhat delay the work of collection and analysis for the current year.

METEOROLOGICAL SUMMARY, L. F. KINNEY, B. S. (p. 147).—Tabulated data on the weather from January 1 to July 1, 1891.

South Carolina Station, Second Annual Report, 1889 (pp. 353).

ACTS RELATING TO THE ORGANIZATION OF THE STATIONS (pp. 5–9).—Under this head are given the texts of the act of the general assembly of the State in 1886 establishing the South Carolina agricultural farms and station; the act of Congress of March 2, 1887, and the acts of the general assembly of the State accepting the provisions of the act of Congress, discontinuing the station at Columbia, and establishing the Clemson Agricultural College and a new station in connection with it.

REPORT OF ANALYST OF SOILS AND SEEDS, R. H. LOUGHRIDGE, PH. D. (pp. 11–43).—This report includes the tabulated results of mechanical and chemical analysis of the soils and subsoils of the experimental farms of the station at Spartanburg, Columbia, and Darlington,

and of sea island cotton and rice-land soils near the coast of South Carolina; a description of the methods of sampling and analysis used; a discussion of the results; and remarks on the requisites of a good soil, on soil analysis in general, with citations from different sources, and on the interpretation of the results of soil examinations, with Professor Hilgard's conclusions on the composition of soils as stated by him in the report on cotton culture, Tenth United States Census, vol. v. Samples were taken of soil and subsoil of each of the experimental farms, which were situated in three representative localities, and separate analyses were made of each sample. In addition to the results of the mechanical and chemical analyses, the calculated number of soil particles per gram of soil and their combined surface area are stated for each grade of the soil and subsoil of each farm. "In order to ascertain how much hygroscopic moisture was absorbed [by each grade of soil particles] from an atmosphere saturated with moisture, tests were made on a soil from the Spartanburg farm, which contained 11.2 per cent of ferric oxide, all of which was contained in the silt and clay." The different sized particles were exposed for a time at 70° F., and then the percentages of moisture lost by the different grades in heating at 200° C. were determined. The tabulated results indicate that the percentages of moisture given off "increase with the lessening diameters of the grains." The author concludes from this trial and from results obtained by Professor Hilgard that "ferric oxide clearly has a large influence in giving soils a large absorption coefficient."

REPORT OF VICE DIRECTOR, M. WHITNEY (pp. 44–96).

Meteorology and the physical properties of soils as related to plant growth and crop production (pp. 44–84 and 86–96).—This includes remarks on the value of the staple crops of the State for experimentation, on the soils of the State, and on the study of typical soils of the State. The investigations include laboratory experiments on the soils of the station farms, sea island upland cotton soils, and upland soils of different geological formations, supplemented by observations in the field and by meteorological studies. The scope of the work undertaken is indicated by the following brief outline: (1) Interpretation of the results of mechanical analysis, including studies on the number of particles in a unit weight or volume of soil, on the diameter of average-sized particles of soil and the mean arrangement of the particles, and on the surface area of particles, the latter showing the need of still further perfecting the method of mechanical analysis of soils; (2) on a movement of soil particles due to changing water content and changing temperature, as related to the growth of roots, and the physical action of manure, with the effect of barometric changes and vapor pressure on the same; (3) method for the determination of the moisture in the soil by electrical resistance; (4) on the movement of soil moisture, including the cause and laws of the movement, and the effect of temperature, manure, rain, cropping, and cultivation on this movement; (5)

calculation of the relative movement of soil moisture in different soils from the mechanical analysis; (6) calculation of the relative rate of evaporation and underdrainage from different soils from the mechanical analysis; (7) on the capillary value of different soils from the mechanical analysis; (8) effect of fineness and compactness on the water-holding power; (9) on the action of underdrains in the soil and on how they act; (10) on the flocculation and subsidence of clay particles; (11) on the swelling of clay when wet; (12) on the compacting of soils by rain; (13) on the physical action of manures and fertilizers; (14) a new form of soil thermometer, which registers the maximum and minimum temperature of a definite layer of soil; (15) the relation of the soil to heat as observed in the field in typical soils or under different conditions of cultivation and fertilization; (16) calculations of the relation of different soils to heat from the mechanical analyses, with the effect of the water content, cultivation, and cropping; (17) the actual temperature of different soils, with range, etc.; (18) study of the loss of heat from different soils, as calculated from the mechanical analysis and as determined with the radiation thermometer; (19) specific heat of typical soils; (20) temperature of the air and soils, and amount of moisture in these most favorable for plant growth; (21) the estimation of the actual amount of moisture in the soils from time to time; (22) influence of meteorological conditions on grain production, as explaining low average yield of grain at the South, on the distribution of crops throughout the State, and on the growth and ripening of crops; (23) amount and intensity of sunshine available for the crop; (24) effect of wind movement on plant growth, especially as to the amount of ammonia supplied to crops.

The following topics are discussed in some detail: The interpretation of the results of mechanical analysis of soils, movement of soil moisture, physical action of manures in improving the drainage of soils, calculation of the rate of movement of soil moisture, and the relation of meteorological conditions to the growth of the cotton crop.

Meteorological data as recorded for each month from November, 1888, to June, 1889, are reprinted from Bulletin No. 7 (new series) of the station (see Experiment Station Record, vol. I, p. 312). These data include the maximum, minimum, and mean temperatures of the air; daily range in temperature of the air; mean height of the barometer; pressure of water vapor in the atmosphere; mean dew-point; mean relative humidity; rainfall; the readings of the solar radiation (maximum) and terrestrial radiation (minimum) thermometers; the difference in temperature between the terrestrial radiation thermometer and the dew-point; daily wind movement; the maximum, minimum, and mean temperatures of the soil (3–9 inches); and the mean weekly temperatures of the soil at different depths. A comparison by seasons is made of the mean meteorological data for Massachusetts, New York, Pennsylvania, South Carolina, Georgia, Alabama, Mississippi, Ohio, Illinois, Indiana, Iowa, Michigan, Minnesota, and Wisconsin.

On the development of cotton roots (pp. 84–86).—Observations on the distribution, extent, and development of the roots of the cotton plant, reprinted from Bulletin No. 7 (new series) of the station (see Experiment Station Record, vol. I, p. 314).

REPORT OF BOTANIST AND ENTOMOLOGIST, E. A. SMYTH, jr., B. A. (pp. 97–108).—Notes on *Pieris protodice*, *P. monuste*, several species of the genus *Colias*, *Neonympha canthus*, *Pamphila ethlius*, *Leucania unipuncta*, and the following insects attacking the fig: *Allorhina nitida*, *Ptychodes trilineatus*, *Libythea bachmanni*, *Apatura celtis*, *A. clyton*, *Grapta interrogationis*, and *Pyrameis atalanta*. There is also an account of the weed *Helenium autumnale*.

REPORT OF CHEMIST, W. B. BURNEY, PH. D. (pp. 109–155).

Feeding stuffs (pp. 109–155).—A popular discussion is given of the nutrition of farm animals, of the nutritive ingredients of feeding stuffs and their functions, and of feeding standards; an explanation of the scientific terms used in the discussion of the subject of feeding, together with a large amount of tabulated data, including analyses of numerous American feeding stuffs, taken from the compilation published by Dr. E. H. Jenkins in the Annual Report of the Connecticut State Station for 1888; the coefficients of digestibility of numerous materials, taken from the Annual Report of the Connecticut State Station for 1886; and the calculated amount of food nutrients required by different kinds of animals under different conditions, per head and per 1,000 pounds live weight, taken from German sources. In addition to the above, analyses made at the station are given of the following materials: Oats, oat straw, rice and its by-products (*i. e.* clean rice, rough rice, rice flour, rice straw, and rice chaff), Texas blue grass, crowfoot (*Eleusine aegyptiaca*), ragweed, corn bran, China berries, and ramie (plant and stems) with reference to both food and fertilizing ingredients; and cotton-seed meal, cotton-seed hulls, and wheat bran with reference to food ingredients.

Analyses of fertilizing materials (pp. 153–155).—Analyses of pine straw (needles), superphosphate, dried blood, muriate of potash, nitrate of soda, Thomas slag, calcined marl, and whole cotton seed.

REPORT OF FIRST ASSISTANT CHEMIST, J. B. MCBRYDE, B. A. (pp. 156–180).—*Chemical statistics of the Indian corn crop of South Carolina* (pp. 156–169).—In this article on the value of the Indian corn plant the remarks of the author are illustrated by analyses of numerous samples of corn (kernels), corncobs, cornshucks (husks), and corn silage with reference to both food and fertilizing ingredients; a statement of the relation of parts of the plant, prepared from observations on the crops grown during 1889 on thirteen different farms; and a comparison of the analyses of South Carolina corn with those of Northern and Western-grown corn, reported in Bulletin No. 96 of the Connecticut State Station (see Experiment Station Record, vol. I, p. 15), and the Annual Report of the Massachusetts State Station for 1889 (see Experiment Station Record, vol. II, p. 579).

The author concludes, with regard to the relation of the parts, that "(1) in an average crop of Indian corn the ear is by weight approximately one half of the entire crop; (2) about four fifths of the ear is grain; and (3) about one half of the stover is stalk."

The cowpea as a forage crop (pp. 169–179).—This is a chemical study of the cowpea plant with reference to both food and fertilizing ingredients. The composition (including fertilizing ingredients) is given of pea-vine hay cut when in bloom, when the pods were forming, and when the pods were formed; the fertilizing ingredients in the roots and stubble are stated; and the hay is compared with oats (grain and straw) and corn (kernels and stover) with regard to composition and the total yield of nutrients, digestible nutrients, and fertilizing ingredients per acre, assuming a yield of 40 bushels of oats, 30 bushels of corn, and 3.6 tons (the yield observed) of cowpea vines.

The pea crop lacks only 481 pounds of containing as much digestible organic matter as the other two crops combined. It contains five times as much crude protein and fat (the most valuable constituents of feeding stuffs) as either oats or corn, and three times as much as their sum. To equal the yield of the cowpea vines in digestible protein (976 pounds) would require 300 bushels of oats including the straw, or 175 bushels of corn including the fodder.

Of digestible carbohydrates the pea affords nearly twice as much as the oats and a little more than the corn. It must be borne in mind that the figures given for oats and corn represent the entire crop, the straw and stover being included.

The relative amounts of fertilizing ingredients per acre contained in the above-mentioned crops are given as follows:

Fertilizing constituents in crop per acre.

	Cowpea vines.	Oats (grain and straw).	Corn (kernels and stover).
	Pounds.	*Pounds.*	*Pounds.*
Nitrogen	205	35	45.0
Phosphoric acid	33	12	14.4
Potash	155	48	45.9
Valuation	$41.82	$8.55	$10.14

As the cowpea obtains a part of its nitrogen from the atmosphere and a part, together with some of its phosphoric acid and potash, from the subsoil, the large amount of these constituents left in its roots and stubble, and dead leaves dropped by the plant, tend to enrich instead of impoverish the soil; in other words, its power of collecting and storing fertilizing materials from sources beyond the reach of the cereals makes the cowpea a valuable remedial crop.

Composition of soja beans (pp. 179, 180).—Analyses (including fertilizing constituents) of soja-bean vines and of hulls and vines after the beans had been threshed.

REPORT OF VETERINARIAN, W. B. NILES, D. V. M. (pp. 181–192).—A reprint of an account of investigations on hog cholera, published in Bulletin No. 6 (new series) of the station (see Experiment Station Record, vol. I, p. 312), with brief statements regarding experiments with

sterilized cultures for the prevention of the disease, and notes on Southern cattle plague.

FIELD EXPERIMENTS, J. M. MCBRYDE, PH. D. (pp. 193–344).—The probable errors in plat experiments are discussed, and a description is given of the field experiments with oats, wheat, corn, cotton, and miscellaneous crops made during 1889 at the experimental farms at Columbia, Spartanburg, and Darlington. Except in cases specified hereinafter, the experiments were duplicated on the three farms. The experiments are in many instances in continuation of those reported in Bulletin No. 5 (new series) and in the Annual Report of the station for 1888 (see Experiment Station Record, vol. I, p. 146, and Experiment Station Bulletin No. 2, part 2, p. 142). In the majority of cases twentieth-acre plats were used.

Experiments with oats (pp. 198–206).—These consist of experiments with fertilizers for oats and variety tests, and were made at all three farms. "On account of the unfavorable season, and especially of the prolonged spring drouth, the crop at all three farms was almost a total failure." The crops at Columbia were destroyed by fire a few days after harvesting. The results obtained at the other two farms are tabulated "in order to preserve the records of our tests."

Experiments with wheat (pp. 206–209).—These were confined exclusively to the Spartanburg farm, and were a continuation of those of the previous year, *i. e.* tests of fertilizers and of varieties. The data for 1888 and 1889 are tabulated. As mentioned above "the season was unfavorable to small grain," but the points noticed in the fertilizer tests of the 2 years are given as follows:

(1) The separate applications of potash, nitrogen, etc., were without effect.

(2) The value of the potash was comparatively slight.

(3) Phosphoric acid was of marked benefit to the crop; when used with the other constituents it was clearly the most important or dominant element.

(4) Nitrogen in combination added largely to the yield.

(5) The half amount or dose of nitrogen was by no means as effective as the full amount [calculated amount contained in a crop of 50 bushels of grain per acre].

(6) The mixed nitrogen [three fourths nitrate of soda and one fourth cotton-seed meal] gave much the best results. The land was very thin and hence the soil was deficient in nitrogen. On account of the absence of this element during the winter the growth of the plants on the other plats was feeble and slow. The addition of some nitrogen in the shape of cotton-seed meal in the fall greatly improved the growth during the winter and early spring, and the superiority thus secured was maintained to the end.

In the variety test, as in 1888, "the South Carolina-grown wheats (Red May and Fultz) gave better returns than the Virginia-grown."

Experiments with corn (pp. 210–268).—"The experiments with corn begun in 1888 were continued in 1889 at all three farms, and included tests of fertilizers (in general), nitrogenous manures, phosphatic manures, modes of applying fertilizers, modes of planting, modes of cultivation, varieties, and rotations. The season of 1889 was very favorable for corn, and excellent crops were harvested throughout the State."

(1) *Fertilizers on corn.*—As in 1888, "in addition to the full amounts of potash, phosphoric acid, and nitrogen (*i. e.* the amounts of each contained in a crop yielding 30 bushels of grain per acre), smaller and larger amounts of each were tested." The yields in 1888 and 1889 are tabulated for each farm, as well as the averages for the three farms.

A comparison of the results for the 2 years shows that the fertilizers gave much better returns at Spartanburg and Darlington in 1889 than in 1888, the increase of yield in the former year amounting to from 75 to 100 per cent. * * * Applied separately or combined in twos the fertilizers gave very poor returns. Potash in small or half doses was of some little benefit. The full amount of phosphoric acid was called for but only half doses of nitrogen. Both constituents were of value to the crop.

Increasing the yield of any one or more of the constituents beyond a certain point (the full or theoretical amount) gave no corresponding increase in the crop. From a pecuniary standpoint but four of the applications gave profitable results.

(2) *Special nitrogen, phosphoric acid, and potash experiments.*—The separate series of experiments to compare the effects on corn of different nitrogen, phosphatic, and potash fertilizers, when each was used in amounts furnishing the same quantity of nitrogen, phosphoric acid, or potash, respectively, were continued in 1889 on all three farms. The results in yield of corn and stover are fully tabulated for each series. The indications from the 2 years' trials are given by the author as follows:

[Nitrogen.] (1) The corn crop does not respond to heavy applications of nitrogenous manures. Moderate amounts will probably give fair returns. In our tests 120 pounds of nitrate of soda proved as effective as 240 pounds; 168 pounds of dried blood as effective as 325 pounds, etc. (2) Of the nitrogenous fertilizers commonly used by our farmers (nitrate of soda, dried blood, cotton-seed meal, and cotton seed whole or ground) one kind appears to be about as effective on Indian corn as another, where equivalent amounts are applied. The employment of any kind should therefore be determined by the cost of its nitrogen. * * *

The results of the tests bear directly upon a question of great practical importance, that of exchanging cotton seed for cotton-seed meal. Many mills offer 700 pounds of meal, and some 1,000 pounds in exchange for 2,000 pounds of seed. Would such exchange be judicious? * * * It appears that as far as these tests go 560 pounds of cotton-seed meal are fully equal in fertilizing value to 1,560 pounds of cotton seed, a proportion of 1 to 2.79. In the oil mills a ton, or 2,000 pounds, of seed gives about 700 pounds of meal, besides oil and some waste product. Now 700 pounds is in proportion to 2,000 pounds as 1, to 2.85. This close correspondence of fertilizing value to output is certainly remarkable.

[Phosphoric acid.] The averages of the three farms for the 2 years show a slight difference in favor of the acid phosphate. The reduced phosphate (containing available phosphoric acid) appears to stand next. The two basic phosphates—Thomas slag and floats—gave about the same average. It appears also that in every case the half amount of phosphoric acid gave nearly as good returns as the full amount. The true results, however, were undoubtedly masked by the dry season of 1888, which prevented the action of the fertilizers at all three farms, and by their failure upon the thin, sandy soil of the Columbia farm both in 1888 and 1889. It is very probable that in favorable years the acid phosphate would show its superiority, for the results thus far reached are in favor of the soluble form.

[Potash.] (1) It is doubtful whether potash was of any real benefit to the crop. (2) It is certain that the full theoretical amount deduced from the analysis of the plant was excessive, and that half this amount was abundantly sufficient (perhaps

more than sufficient) for the needs of the crop and soil. (3) Of the three potassic manures tested, one kind was about as effective as another (when equivalent amounts were applied). Hence the employment of any one of the three is simply a question of its cost.

(3) *Modes of applying fertilizers for corn.*—A comparison of fertilizers applied broadcast and in drills on the same plan as that followed in 1888. The indications were the same as in the preceding year, *i. e.* "the two methods of applying manures gave practically the same average returns."

(4) *Modes of planting corn.*—A 2-years' trial of planting in drills and hills (checking), according to the plan detailed in the first year's report, seemed to show "that one method of planting gave about as good results as the other, and that it made little difference whether the rows were 5 or 6 feet apart, or the checks 5 feet by 3 feet or 6 feet by 3 feet."

(5) *Modes of cultivating corn.*—As in 1888, this was a test of "(1) the advantages of subsoiling the seed furrow before planting; (2) the comparative effects of deep and shallow cultivation; and (3) the value of thorough cultivation." As between the different methods the results for the 2 years showed "surprisingly little difference. * * * It appears that subsoiling the seed furrow did not improve the crop, and that deep culture and imperfect tillage did not materially affect it. It should be explained, however, that our 'ordinary cultivation,' that is the cultivation given to all the other plats, was much more thorough than the tillage given on the average farm." It is believed that the advantages of thorough cultivation would have been more apparent on heavy soils than on the light soils used.

(6) *Varieties of corn.*—Tests at the Columbia farm of 9 varieties of corn.

(7) *Rotations for corn.*—Tabulated data on the yields in 1889 of the series of rotations for corn commenced in 1888. "Up to this time protective and green crops [oats and peas] grown along with the corn have not materially affected the yield one way or another."

Experiments with cotton (pp. 268–342).—"The experiments with cotton may be classified as follows: Tests of varieties, fertilizers in general, nitrogenous manures, phosphatic manures, potassic manures, composts, methods of applying manures, time for applying nitrate of soda, modes of planting, topping, and rotations. * * * Amounts of potash, phosphoric acid, and nitrogen found by analysis in a crop yielding 300 pounds of lint per acre were applied, except where otherwise mentioned. These are called the full amounts or doses."

The season of 1889 is said to have been very unfavorable for cotton in many parts of the State.

(1) *Tests of varieties.*—The results are given of tests of 15 varieties of cotton at Spartanburg, 47 at Columbia, and 18 at Darlington in 1889; the averages of 8 varieties tested at all three farms for 2 years; and the averages for varieties tested for several years at the Columbia farm

as follows: 41 varieties for 2 years, 37 for 3 years, 25 for 4 years, 13 for 6 years, and 7 for 7 years.

"The old Rio Grande (under the names of Texas Wood, Peterkin, Crosland, etc.) is certainly entitled, from the results of our numerous tests, to the position of honor."

(2) *Fertilizers on cotton.*—The tests commenced in 1888 at each of the three farms were continued without change in 1889. Although the crop of 1889 was in general unsatisfactory, the indications of the 2-years' trial were that—

Marl and copperas produced no effect upon the crop; separate applications of potash, phosphoric acid, and nitrogen were equally valueless; their combinations produced marked effects; phosphoric acid and nitrogen played the most important parts; potash was of relatively less value than the other two; excessive applications of one or all three gave no adequate returns; the proportions indicated by analysis were not the correct ones; probably one half potash, one phosphoric acid, and one half nitrogen would be nearer approximations to the requirements of the plant. There is reason to believe, however, that the potash might be reduced to one third, and the phosphoric acid and nitrogen, respectively, increased to one and one half and two thirds with advantage.

(3) *Special nitrogen, phosphoric acid, and potash experiments.*—These experiments were in all respects similar to the corresponding series with corn mentioned above, and were in continuation of experiments in 1888. The data are fully tabulated for each farm, together with the averages for the 2 years. The following summary of the results is by the author:

[Nitrogen.] (1) Stable manure gave the best average for the 2 years at each of the three farms. The double dose [12 tons per acre] increased the crop, as compared with the full dose, by from 75 to 100 pounds lint per acre. At Spartanburg and Darlington the mixture of stable manure and nitrate of soda gave as good results as the equivalent amount of stable manure, and as good a combined average for the three farms.

(2) The differences between the combined averages of the other kinds (nitrate of soda, dried blood, cotton-seed meal, and cotton seed whole or ground) were comparatively slight. The dried blood gave rather the best average.

(3) Heavy doses of nitrogen were not required by cotton. In nearly every case the half dose gave as good results as the full.

(4) The point of most importance to our farmers is the remarkably close agreement in the combined averages of cotton-seed meal, whole cotton seed, and ground cotton seed. * * * Seven hundred and forty-five pounds of the cotton seed meal were fully equal in fertilizing value to 2,080 pounds of cotton seed (whether whole or ground), that is to say, 1 pound of the meal was equal to 2.79 pounds of seed [the same proportion as was found in the corn experiments].

[Phosphoric acid.] The superiority of the acid phosphate is clearly shown throughout. Its average for the 2 years at each farm largely exceeded those of the other three kinds. Reduced phosphate gave the next best averages. The slag and floats gave very nearly the same returns. The half doses proved inferior to the full.

[Potash.] The agreement in the average results of both the full and half doses of the three potassic manures is remarkably close. They abundantly confirm those of the similar tests with corn. One source of potash is as good as another and the farmer's choice must be determined by the price of the potash in each and the freight charges. As a general rule kainit would be preferred for the above reasons.

(4) *Composts on cotton.*—This is a trial at the Columbia farm of the eight composts tested in 1888. All of the composts gave as good results as the complete fertilizer supplying the theoretical amounts of ingredients.

(5) *Modes of applying fertilizers for cotton.*—These experiments were to compare the effects of applying fertilizers broadcast and in the hill. As in the previous year, fertilizers containing the full and one half the theoretical amounts of ingredients were applied broadcast and in the hill, the same amount per acre being used in either case.

"From all the results of the above tests it would appear to follow that where heavy amounts of fertilizers are used one mode of application answers just as well as the other, but that moderate amounts can be applied more effectively in the drill. When applied by hand the cost of each method is the same."

(6) *Time for applying nitrate of soda.*—Experiments were begun in 1889 at the Columbia and Darlington farms to secure data as to the best time for applying nitrate of soda—whether at time of planting or in top-dressings during the growing season. Using the full theoretical amounts of nitrogen (as nitrate of soda), phosphoric acid, and potash in all cases, the nitrogen was applied in one case half at time of planting and half later, and in another case in two top-dressings about 3 weeks apart. The land selected at Darlington proved so uneven "as to vitiate the results." The results at Columbia indicated "a slight difference in favor of applying all the nitrate of soda in top-dressings upon the growing crops."

(7) *Different proportions of nitrogen, phosphoric acid, and potash for cotton.*—The results are tabulated for experiments made in 1889 at the Columbia and Darlington farms with a view to ascertaining the proportion of nitrogen, phosphoric acid, and potash required by the cotton crop. The season was so unfavorable at Columbia and the land so uneven at Darlington that the results furnished no reliable indications.

(8) *Modes of planting cotton.*—A continuation of the comparison of checking and drilling commenced in 1888. Tables show the average results of twelve tests, two at each of the three farms for 2 years. "The close agreement in the returns of the checked and drilled plats is remarkable. It appears that either mode of planting may be indifferently employed, and that the distance within the limits tested matters little. Our tests, however, cover a period of only 2 years, one of which was very unfavorable for cotton."

(9) *Topping cotton.*—Tests at two farms in 1888 and 1889, in which the cotton on one plat was topped and that on another was not topped, indicated that "topping produced no beneficial effects and involved an unnecessary outlay."

(10) *Rotations of cotton.*—Tabulated data are given on the yields of cotton in 1889 under each of the eleven systems inaugurated the year

previous. While "it is of course too early as yet to expect results," attention is called to the following points:

(1) Thus far peas along with the cotton, oats sowed among the cotton plants in the fall and turned under in the spring, and the return of the [cotton] seed of the preceding year alone or in connection with the pea or oat crop, have been of but slight benefit to the cotton.

(2) The difference between the effects of peas and oats is slight.

(3) As remarked under the head of the rotations for corn, the pea and oat crops were certainly grown without injury to the cotton crop of the same year.

Miscellaneous crops (pp. 342–344).—This includes brief remarks on tobacco, sorghum, sugar cane, and soja beans raised at the station, and a statement of the yields and in some cases of the estimated financial results.

Report of Treasurer, I. H. Means (p. 345).—An exhibit of the receipts and expenditures of the station for the fiscal year ending June 30, 1889.

Tennessee Station, Bulletin Vol. IV, No. 3, July, 1891 (pp. 22).

The Heteroptera of Tennessee, H. E. Summers (pp. 75–96, plate 1, figs. 12).—This includes an illustrated account of the terms used in describing insects, a key to the families of *Heteroptera*, and classified accounts of insects of this order which are found in Tennessee, together with suggestions as to remedies for these insects, and a description of spraying apparatus.

Texas Station, Bulletin No. 17, August, 1891 (pp. 16).

General information regarding the station, G. W. Curtis, M. S. A. (pp. 109–122).—The acts of Congress and of the State legislature under which the station was established, a brief account of the organization of the station, with lists of officers, a summary of the results of experiments, an outline of the work in progress, an inventory of station property, and a financial statement for each year during which the station has been in operation.

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF STATISTICS.

REPORT NO. 89 (NEW SERIES), OCTOBER, 1891 (pp. 521–590).—This includes articles on the yield per acre of wheat, rye, barley, and oats; the condition of corn, potatoes, buckwheat, and tobacco October 1; the crop of flaxseed in 1891; the wine industry of Napa County, California; foreign tariffs on agricultural products; tariffs under reciprocity treaties; agriculture in Bolivia and Japan: European crop report for October; and transportation rates for October.

Flaxseed.—A special investigation, undertaken for the purpose of ascertaining the production of flaxseed this year, shows that there has been a large increase in the area devoted to this crop during the last 2 years, the increment being entirely west of the Mississippi River, and confined mainly to the States of Minnesota, Iowa, Kansas, Nebraska, and the Dakotas. The acreage for 1891 is estimated at 1,927,293 acres, and the product of seed 15,455,272 bushels. The season was mainly favorable and the average yield large. * * *

The enlargement is in those districts having the larger proportion of new lands. * * * Flax has been found the best crop for first cultivation on sod land, assisting in getting the soil into good tilth for other crops, besides being a money crop. * * * Another potent reason, however, for the heavy enlargement during the past 2 years is the fact that there has been a steady demand for flaxseed at prices which have paid for its cultivation better than the returns from wheat growing. * * * An increased acreage based upon such reasons can not be permanent, and already, with lower offerings on the farm for the seed, there are indications that some portion of the area will be abandoned next year.

Under present conditions the crop is grown almost entirely for seed, the fiber not being made use of to any great extent. * * * As many correspondents declare, flax growing for the seed alone does not pay except as a first crop. The future of the industry depends upon the utilization of the fiber as well as of the seed. There are indications in some sections of the Northwest, especially in Minnesota, of popular interest in the question of establishing a fiber industry; and in fact this interest has been a factor in the increase in the area given to flax in that State.

DIVISION OF ENTOMOLOGY.

INSECT LIFE, VOL. IV, NOS. 1 AND 2, OCTOBER, 1891 (pp. 86, fig. 1).—This double number consists for the most part of the proceedings of the Association of Economic Entomologists held at Washington,

D. C., August 17 and 18, 1891. The President's inaugural address was delivered by J. Fletcher of Canada. The following papers were read: Destructive Locusts of North America, together with Notes on the Occurrences in 1891, by L. Bruner of Nebraska; *Chilo saccharalis* in New Mexico, The White Grub of *Allorhina*, and Miscellaneous Notes, by C. H. T. Townsend of New Mexico; Notes on Blackberry Borers and Gall Makers, and The Squash Borer (*Melittia cucurbitæ*) and Remedies therefor, by J. B. Smith of New Jersey; Notes on the Cotton Cutworm (*Agrotis annexa*), and A Nematode Leaf Disease (*Aphelenchus* sp.), by G. F. Atkinson of Alabama; Kerosene Emulsion and Pyrethrum, by C. V. Riley of the U. S. Department of Agriculture; Work of the Season in Mississippi, by H. E. Weed of Mississippi; Note on the Horn Fly (*Hæmatobia serrata*) in Ohio, by D. S. Kellicott, of Ohio; Notes of the Season, by E. A. Ormerod of England; Notes on the Recent Outbreak of *Dissosteira longipennis*, by E. A. Popenoe of Kansas; Notes on a Corn Crambid (*Crambus caliginosellus*), by M. H. Beckwith of Delaware; Notes of the Year in New Jersey, by J. B. Smith of New Jersey; Government Work and the Patent Office, by C. V. Riley of the U. S. Department of Agriculture; A Note on Parasites, by L. O. Howard of the U. S. Department of Agriculture; Report of a Trip to Kansas to Investigate Reported Damages from Grasshoppers, by H. Osborn, of Iowa; The Clover Seed Caterpillar (*Grapholitha interstinctana*, Clem.), by H. Osborn and H. A. Gossard of Iowa; Standard Fittings for Spraying Machinery, by W. B. Alwood of Virginia; Entomological Work in Central Park, by E. B. Southwick of New York; Some Historic Notes, by A. J. Cook of Michigan; An Experiment with Kerosene Emulsions, by H. Osborn of Iowa; A Note on Silk Culture, by P. Wallace of California; Notes on a few Borers, by G. C. Davis of Michigan; The Poplar Gonioctena (*Gonioctena pallida*, Linn.), by A. J. Cook of Michigan; Notes of the Season from South Dakota, by J. M. Aldrich of South Dakota; A Note on Remedies for the Horn Fly, by W. B. Alwood of Virginia; The Chinch Bug Disease and other Notes, by F. H. Snow of Kansas.

DIVISION OF VEGETABLE PATHOLOGY.

JOURNAL OF MYCOLOGY, VOL. VII, NO. 1, SEPTEMBER 10, 1891 (pp. 63, plates 10).—This number includes articles on Sweet Potato Black Rot (*Ceratocystis fimbriata*, E. and Hals.), by B. D. Halsted and D. G. Fairchild; Experiments in the Treatment of Plant Diseases, part III, by B. T. Galloway; Diseases of the Orange in Florida, by L. M. Underwood; Peach Blight (*Monilia fructigena*, Persoon), by E. F. Smith; the improved Japy Knapsack Sprayer, by B. T. Galloway; Notes on some Uredineæ of the United States, by P. Dietel; New Species of Uredineæ (*Puccinia hemizoniæ*, *Æcidium oldenlandianum*, and *Æ. malvastri*), by J. B. Ellis and S. M. Tracy; A New Pine Leaf Rust (*Coleosporium pini*), by B. T. Galloway; Observations on New Species of Fungi

from North and South America—*Puccinia heterogenea, Uredo gossypii, Doassansia gossypii, Peronospora gonolobi*; Reviews of Recent Literature—*Untersuchungen aus dem Gesammtgebiete der Mykologie, Heft IX*, Münster (Dr. Oscar Brefeld); *Crittogamia Agraria*, Naples (Dr. O. Comes); *Der falsche Mehltau, sein Wesen und seine Bekämpfung*, Zurich (J. Morgenthaler); Index to North American Mycological Literature (continued), by D. G. Fairchild.

OFFICE OF IRRIGATION INQUIRY.

Progress Report on Irrigation in the United States (pp. 337, plates 5).—This includes articles on Irrigation in the United States, by R. J. Hinton; Artesian and Underflow Investigation, by R. Hay and by J. W. Gregory; Progress of Irrigation in Montana, Idaho, eastern Washington, and Oregon in 1890, by J. W. Nimmo, jr.; Irrigation Statistics and Progress in Colorado for 1890, by L. G. Carpenter; Artesian Water in Nevada, by C. W. Irish; Phreatic Waters in Nye County, Nevada, by G. Nichols; Imbibition of Rocks, by R. T. Hill; The Cultivation of the Raisin Grape of California by Irrigation, condensed from a recent publication by G. Eisen; Irrigation in Australia, by R. J. Hinton; and Alkali Soils and Waters in California, condensed from reports by E. W. Hilgard. A large amount of information is given regarding the history, present condition, methods, and legal relations of irrigation in the United States.

Lands under ditch in the arid and semiarid region.

States.	Under ditch.		Under cultivation, 1890.
	1889.	1890.	
	Acres.	*Acres.*	*Acres.*
Arizona*	529, 200	643, 450	310, 100
California	3, 294, 000	4, 044, 000	2, 444, 000
Colorado	2, 813, 273	4, 004, 009	1, 585, 000
Idaho	715, 500	1, 181, 500	327, 000
Kansas (western)	500, 000	860, 010	100, 000
Montana	986, 000	1, 100, 000	400, 000
Nebraska (western)	50, 000	65, 000	10, 000
Nevada	142, 000	150, 000	75, 000
New Mexico	638, 455	677, 315	450, 000
Oregon (eastern)	75, 000	100, 000	45, 000
South Dakota (Black Hills)	100, 000	100, 000	20, 000
Elsewhere in the Dakotas	....	2, 000	2, 000
Texas	200, 000	340, 000	160, 000
Utah	700, 000	700, 000	413, 000
Wyoming	1, 946, 876	1, 946, 876	175, 000
Wyoming (eastern)	75, 000	150, 000	60, 000
Total	12, 764, 304	16, 064, 160	7, 576, 100

* In Arizona for 1890 two estimates were sent in, one of 587,460 acres under ditch and 295,200 cultivated acres, by the Acting Governor; the other, 699,440 acres under ditch and 325,000 cultivated, by Government officers. The figures above are the mean of the two estimates.

It may safely be assumed that there are very many small irrigated areas scattered throughout the arid region which are not included in these estimates. There are also larger areas, not many in number, perhaps, in which the use of water for irrigating natural and cultivated grasses is of considerable importance. No estimate is

attempted of the small irrigations of house gardens, lawns, and fruit trees which prevail in every city, town, and village west of the ninety-seventh meridian. Altogether it will not be unreasonable to suppose that the area actually cultivated in 1890 reaches at least 8,000,000 acres.

Estimated areas of arid lands reclaimable by irrigation.

Political divisions.	Reclaimable by irrigation.	Political divisions.	Reclaimable by irrigation.
	Acres.		*Acres.*
California	25,000,000	Wyoming	12,000,000
Colorado	20,000,000	Public land strip	2,000,000
Dakotas, North and South	33,000,000	Texas, west of 97°	20,000,000
Nevada	7,000,000	Oregon and Washington, east of Cascade Range	20,000,000
Arizona	12,000,000		
Montana	30,000,000	Kansas, Nebraska, Oklahoma, and Indian Territory, west of 97°	30,000,000
Idaho	10,000,000		
New Mexico	14,000,000		
Utah	10,000,000	Total	245,000,000

ARTESIAN AND UNDERFLOW INVESTIGATION IN NEBRASKA AND KANSAS, E. S. NETTLETON (pp. 14, maps and tables 12).—A report on investigations in November and December, 1890, in the valleys of the Platte and Arkansas Rivers. The author states that in Kansas and Nebraska—

The necessity for irrigation is growing less and the line separating the humid from the semiarid regions is moving westward. This movement is, however, growing slower and slower with each degree covered, and the point where it will stop will somewhere be reached. * * * The difference in the final outcome of irrigation development in Kansas and Nebraska and that in Colorado will be that irrigation in Kansas and Nebraska will be confined to disconnected and smaller irrigation districts and the more general utilization of the underground waters, and doubtless a much smaller percentage of land cultivated by aid of irrigation.

The various methods of irrigation available to a greater or less extent for this region are as follows:

(1) The use of subterranean water obtained by open subflow ditches.

(2) The use of subterranean waters raised a few feet by mechanical means.

(3) The use of subterranean waters raised from the ordinary farm wells by windmills.

(4) The use of the small perennial flow of the streams on the plains.

(5) The storage and immediate use of storm waters.

(6) The use of the flow of artesian wells.

WEATHER BUREAU.

SPECIAL REPORT FOR 1891, M. W. HARRINGTON (pp. 26).—This includes general statements regarding the reorganization of the Bureau after its transfer to this Department July 1, 1891, and accounts of the operations of the different branches of the Bureau. "Local forecast officials" have been appointed at the larger cities, who are to study especially the climatology and topography of their respective sections, as well as the relation of the weather to the growth of crops. These observers are permitted to predict the weather for more than 1 day

in advance. The number of places where weather maps are issued has been increased to over 60 and the distribution of the maps has been enlarged, especially in agricultural communities. The cotton region reports are now sent to the State weather service headquarters, as well as to the Weather Bureau centers, and telegraphic information of the first killing frost at every cotton region station will hereafter be included in these reports. A similar service is contemplated for the sugar region. An exhibition showing the working of a Weather Bureau station was recently made at a fair at Albany, New York, and it is intended to make these displays at other places. The method of preparing and distributing the weather forecast is described in outline. States and Territorial weather services have been organized since July 1 in 11 States and Territories, making 39 such services now in operation. More than 100 new voluntary meteorological stations have been established. The number of weather signal display stations has been increased from 630 to over 1,200. An index of meteorological observations in the United States is being prepared for distribution to the principal stations of the Bureau with a view to giving greater publicity to the data in the records of the office. There are at present about 2,200 voluntary observers in the United States, an increase of about 400 in 3 months. A liberal policy in providing these observers with instruments and information is recommended. An index to foreign meteorological observations is being prepared. Other topics treated in the report are the Pacific Coast division of the Bureau, river and flood service, telegraph service, the instrument room, monthly weather review, bibliography of meteorology, international conference of meteorologists, and the relations of the Bureau to the agricultural colleges and experiment stations.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

Experiments on root tubercles and the fixation of atmospheric nitrogen, J. B. Lawes and J. H. Gilbert.—[As stated in the account of the meeting of the section for agricultural chemistry of the German Association for the advancement of science (*Abtheilung für Agrikulturchemie und landwirthschaftliches Versuchswesen der Gesellschaft deutscher Naturforscher und Aerzte*) at Halle, in the Experiment Station Record, vol. III, p. 207, a paper was presented by Prof. J. H. Gilbert, LL. D., F. R. S., on the results of experiments at Rothamsted on the fixation of free nitrogen by plants, with special reference to the occurrence and functions of root tubercles. The following abstract of his paper has been furnished by Professor Gilbert:]

From the results of the experiments of Boussingault and also of those made at Rothamsted under conditions of sterilization and inclosure more than 30 years ago, Sir J. B. Lawes and J. H. Gilbert had always concluded that at any rate our agricultural plants did not assimilate free nitrogen. They had also abundant evidence that the Papilionaceæ as well as other plants derived much nitrogen from the combined nitrogen in the soil and subsoil. Still they had long recognized that the source of the whole of the nitrogen of the Papilionaceæ was not explained, that there was in fact "a missing link." They were therefore prepared to recognize the importance of the results regarding the root tubercles and their connection with the assimilation of nitrogen by legumes,* first announced by Professor Hellriegel in 1886, and they had hoped to commence experiments on the subject in 1887, but they had not been able to do so until 1888. These first results showed a considerable formation of nodules on the roots, and, coincidently, great gain of nitrogen in plants grown in sand (with the plant ash) when it was microbe-seeded with a turbid watery extract of a rich soil.

In 1889 and since they made a more extended series of experiments. The plants were grown in pots in a glass house. There were four pots of each description of plant, one with sterilized sand and the plant

*A brief review of the history of investigations in this line was given by Professor Gilbert, but was not deemed by him essential for this abstract, which is intended to present only the general plan and results of the last Rothamsted investigations, with a few typical illustrations selected from a large number of experiments. For a review of this subject see Experiment Station Record, vol. II, p. 686, and vol. III, p. 56.

ash; two with the same sand and ash, but microbe-seeded with watery extract for some plants from a rich garden soil, for lupines from a sandy soil in which lupines were growing luxuriantly, and for some other plants from soil where the particular plant was growing. In all, in 1889 and subsequently, they had grown in this way four descriptions of annual plants, namely, peas, beans, vetches, and yellow lupines, and four descriptions of longer-lived plants, namely, white clover, red clover, sainfoin, and lucern. Without microbe-seeding there was neither nodule formation nor any gain of nitrogen; but with microbe-seeding there was nodule formation, and, coincidently, considerable gain of nitrogen.

However, as in this exact quantitative series the plants were not taken up until they were nearly ripe, it is obvious that the roots and their nodules could not be examined during growth, but only at the conclusion, when it was to be supposed that the contents of the nodules would be to a great extent exhausted. Another series was therefore undertaken in which the same four annuals and the same four plants of longer life were grown in specially made pots, so arranged that some of the plants of each description could be taken up and their roots and nodules studied at successive periods of growth; the annuals at three periods, (1) when active vegetation was well established, (2) when it was supposed that the point of maximum accumulation had been approximately reached, and (3) when nearly ripe; and the plants of longer life at four periods, (1) at the end of the first year; (2) in the second year, when active vegetation was reëstablished; (3) when the point of maximum accumulation had been reached; and (4) when the seed was nearly ripe. Each of the eight descriptions of plants was grown in sand (with the plant ash) watered with the extract from a rich soil; also in a mixture of two parts of rich garden soil and one part of sand. In the sand the infection was comparatively local and limited, but some of the nodules developed to a great size on the roots of the weak plants so grown. In the rich soil the infection was much more general over the whole area of the roots; the nodules were much more numerous, but generally very much smaller. Eventually the nodules were picked off the roots, counted, weighed, and the dry substance and the nitrogen in them determined.

Taking the peas as typical of the annuals and the sainfoin of the plants of longer life, the general result was that at the third period of growth of the peas in sand the amount of dry matter of the nodules was very much diminished, the percentage of nitrogen in the dry matter was very much reduced, and the actual quantity of nitrogen remaining in the total nodules was also very much reduced, in fact the nitrogen of the nodules was almost exhausted. The peas grown in rich soil, however, maintained much more vegetative activity at the conclusion, and showed a very great increase in the number of nodules from the first to the third period, and with this there was also much more dry substance and even a greater actual quantity of nitrogen in the total

nodules at the conclusion. Still, as in the peas grown in sand, the percentage of nitrogen in the dry substance of the nodules was very much reduced at the conclusion. In the case of the plant of longer life—the sainfoin—there was, both in sand and in soil, very great increase in the number of nodules and also in the actual amount of dry substance and of nitrogen in them as the growth progressed. The percentage of nitrogen in the dry substance of the nodules also showed, even in the sand, comparatively little reduction, and in soil even an increase. In fact, separate analyses of nodules of different character or in different conditions showed that while some were more or less exhausted and contained a low percentage of nitrogen, others contained a high percentage and were doubtless new and active. Thus the results pointed to the interesting conclusion that although with the plant of longer life the earlier-formed nodules became exhausted, others were constantly produced to provide for future growth.

As to the explanation of the fixation of free nitrogen, the facts at command did not favor the conclusion that under the influence of the symbiosis the higher plant itself was enabled to fix the free nitrogen of the air by its leaves; nor did the evidence point to the conclusion that the nodule bacteria became distributed through the soil and there fixed free nitrogen, the compounds of nitrogen so produced being taken up by the higher plant. It seemed more consistent, both with experimental results and with general ideas, to suppose that the nodule bacteria fixed free nitrogen within the plant, and that the higher plant absorbed the nitrogenous compounds produced. In other words, there was no evidence that the chlorophyllous plant itself fixed free nitrogen, or that the fixation takes place within the soil, but it was more probable that the lower organisms fix the free nitrogen. If this should eventually be established we have to recognize a new power of living organisms—that of assimilating an elementary substance. But this would only be an extension of the fact that lower organisms are capable of performing assimilation work which the higher can not accomplish, while it would be a further instance of lower organisms serving the higher. Finally it may here be observed that Loew has suggested that the vegetable cell with its active protoplasm, if in an alkaline condition, might fix free nitrogen, with the formation of ammonium nitrate. Without passing any judgment on this point, it may be stated that it has frequently been found at Rothamsted that the contents of the nodules have a weak alkaline reaction when in apparently an active condition, that is while still flesh-red and glistening.

As to the importance of the fixation for agriculture and for vegetation generally, there is also much yet to learn. It is obvious that different Papilionaceæ, growing under the same external conditions, manifest very different susceptibility to or power to take advantage of the symbiosis, and under its influence may gain much nitrogen. This is of interest from a scientific point of view as serving to explain the source of

some of the combined nitrogen accumulated through ages on the surface of the globe; and also from a practical point of view, since, especially in tropical countries, such plants yield many important food materials, as well as other industrial products.

Root tubercles and acquisition of nitrogen by legumes—inoculation experiments in field culture, Hellriegel and Wilfarth.—In the account given in the present volume of the Experiment Station Record, p. 207, of the meetings of the section for agricultural chemistry of the German Association for the advancement of science at Halle, in September, 1891, mention was made of a somewhat informal report by Professor Hellriegel, director of the experiment station at Bernburg, on the continuation of his investigations upon root tubercles and the fixation of atmospheric nitrogen by plants.

It will be remembered that the experiments of Professor Hellriegel have been made mostly by the method of sand culture, which he has developed by many years of experimental inquiry, and that although the acquisition of large quantities of atmospheric nitrogen by leguminous plants had been demonstrated before Hellriegel's work at Bernburg on this subject was undertaken, yet it was through those investigations that the connection between root tubercles, bacteria, and the fixation of nitrogen was first found out. Few discoveries in biological and agricultural chemistry have brought or promise to bring such an important train of results as this. The development of the subject by various experiments has been recorded from time to time in the Record (vols. I, p. 194; II, p. 686, and III, pp. 56, 116). Through the courtesy of Professor Hellriegel and of Dr. Wilfarth, who has been associated with him in these investigations, the following résumé of their latest results, preceded by a brief recapitulation of the earlier work at Bernburg, has been furnished by the latter gentleman for publication in the Record:

Previous investigations had shown that while the leguminous plants can avail themselves of the free nitrogen of the air, they can do this only when certain kinds of bacteria have entered them and caused the production of the root tubercles characteristic of the legumes. Leguminous plants which are cultivated in sterilized media and kept free from bacteria during their growth, so as to prevent this symbiosis, and which in consequence have no tubercles, do not acquire nitrogen from the air. Thus cultivated they behave like the non-leguminous plants, which, as experiments have repeatedly shown, can not assimilate free nitrogen.

During the last few years a series of experiments has been going on at Bernburg with legumes which have been kept under conditions of sterility. These experiments have brought out the fact that the legumes thus kept sterile not only failed to fix nitrogen, as just stated, but also when they were well supplied with other food and deprived of nitrogen compounds in the medium in which they grew, remained in a starved condition, though they grew well when nitrogen compounds were supplied.

The later experiments have shown still further that the sterilized legumes develop exactly in proportion to the amount of nitrogen furnished in the soil and that if enough nitrogen is thus supplied the plants grow luxuriantly and show a perfectly normal development of seeds. Of course a very abundant supply of nitrogen is necessary. The experiments have shown that it must be applied in a form best suited to the plants. It was found that ammonium nitrate is the most appropriate form for supplying leguminous plants with nitrogen. Other compounds, such as calcium nitrate, do not agree so well with them. Lupines fed with the latter compound become sickly and their development is imperfect.

The statements just made refer to plants cultivated in pure sand by Hellriegel's method. By this method healthy plants and especially a normal development of seeds, can be obtained. This is illustrated by trials with lupine plants in two pots of equal size, one containing natural soil with bacteria, the other sterilized sand. Two plants were grown in each pot. The weights of the plants produced (stems, leaves, and fruit, but not the roots) were, (1) in a natural soil with symbiosis, 41.08 grams of dry substance, of which the seeds were 25.7 per cent; (2) in sterilized sand with ammonium nitrate, 40.79 grams of dry substance, of which 26.7 per cent were seeds.

A number of experiments were made in pots with natural soil. Whenever the soil was not sterilized the leguminous plants had tubercles on the roots and a notable acquisition of nitrogen was found. When they were kept sterile the plants grew only in proportion to the nitrogen contained in the soil, but when nitrogenous fertilizing material was added to the sterilized cultures, the amount of plant growth increased in proportion to the amount of nitrogen supplied. The roots had no tubercles and there was no evidence of acquisition of atmospheric nitrogen. In this way the same principle is found to apply to culture in soil containing humus, as in pure sand. The view of Frank, who claims especial effects in humus soils, is thus refuted.

Besides these pot experiments a series of field trials were made with lupine and serradella to study the effects of inoculating with bacteria.

The experiments at Bernburg bring out the fact (which has been confirmed by other observations, *e. g.*, those of Nobbe, described in the present number of the Record, page 336) that different leguminous plants do not avail themselves of the same kind of bacteria, but rather that a given species may require a special form for the symbiosis by which the free nitrogen is fixed. Thus, for instance, the root tubercle bacteria of peas do not produce tubercles in lupines and serradella, and therefore do not enable them to acquire nitrogen from the air. Now these different forms of bacteria are not found in all arable soils. Thus the cultivated soils in the vicinity of Bernburg contain an abundance of pea bacteria, but none or very few of the lupine bacteria, because lupines have never been cultivated in this region. On the other hand,

in regions where the cultivation of these plants has been carried on for many years the soil is full of lupine bacteria.

In such a region a quantity of surface soil was procured from a field where lupines had been raised, carried to Bernburg, and used for inoculation in the field trials. For these latter a number of narrow strips of the experimental fields of the station were planted with yellow, blue, and white lupines. On some of these strips the lupine soil was applied in different quantities and plowed under to different depths, while other strips received none of the lupine soil. The quantities of inoculating soil used on the different strips were 10, 25, 50, 100, and 200 *Centner* per hectare, or from 446 to 8,925 pounds avoirdupois per acre. Similar experiments were made with serradella.

The field was in pretty fair condition as to manuring, so that even the plants which were not inoculated could develop tolerably well by feeding on the nitrogen of the soil. Nevertheless the effect of the inoculation was plainly manifest on all the strips. At the time of blooming all plants which had been treated with lupine soil were easily distinguishable to the eye, even at a distance, by their greener color and better development. The differences in the plants with the different quantities of inoculating soil were likewise plainly visible, the effect increasing with the amount applied; indeed with the largest quantity the effect was excessive, so that in some places the plants lodged. The inoculation was equivalent in effect to the addition of nitrogenous manure.

In order to compare the plants, and especially the roots, pieces 1 square meter in size were dug out of the different strips. Here again the effect of the inoculating soil was plain. In strips without inoculation there were some plants, especially among the yellow lupines, which had root tubercles, but the tubercles were generally on the branch roots and not very well developed. The inoculated plants, however, had large, healthy tubercles on the main roots, and the number of tubercles increased with the increase in the quantity of soil used for inoculation. Upon the strips which had not been inoculated from 99 to 100 per cent of the plants of the blue and white lupines were found to be without tubercles, while on the inoculated strips from 74 to 100 per cent had tubercles, the number varying with the amount of inoculating soil. There is no doubt that when the quantitative yields of the plants are determined they will show notable increase with the inoculation.

These experiments of the last few years, taken altogether, completely confirm the propositions set forth as the result of the earlier investigations by the station.—[W. O. A.]

Experiments in the assimilation of nitrogen by leguminous plants, F. Nobbe, E. Schmid, L. Hiltner, and E. Hotter (*Landw. Vers. Stat., 39, pp. 327–359*).—The experiments here reported were carried out during 1890 at the experiment station at Tharand, Saxony.

At the time the experiments were planned the investigations of Prazmowski had not been made public. The plants used were peas, yellow lupine, beans (*Phaseolus vulgaris*), common locust (*Robinia pseudacacia*), honey locust (*Gleditschia triacanthos*), and laburnum (*Cytisus Laburnum*), the object being (1) to test the fixation of nitrogen by certain papilionaceous trees; (2) to study the effects of using for the inoculation of the plants of the different genera, (*a*) extracts of soils in which each of the above-mentioned plants have been previously grown, and (*b*) pure cultures of bacteria prepared from soil infusions and from root tubercles; and (3) to determine whether the same form of bacteria is capable of causing the growth of tubercles on leguminous plants of different genera, or whether a special form exists for each kind of plant, with which alone they are capable of living in symbiosis.

The experiments were carried out in glass vessels of 6.5 liters capacity. Each vessel had three openings in the sides, just above the bottom. About a quart of pebbles was placed in the bottom of each jar, above this a layer of sterilized cotton batting, and then the soil, which was likewise covered with a layer of cotton. This artificial soil consisted of pure sterilized quartz sand, with 5 per cent by weight of peat* (previously treated to extract nitrogen). To this was added half a per cent of chemically pure calcium carbonate and a quantity of a nutritive solution. The materials were all sterilized before filling in the vessels, and each vessel and its contents were afterwards sterilized by heating to 95° C. on 3 separate days. Five plants were grown in each vessel.

The soil infusions were prepared by thoroughly shaking 60 grams of soil with 300 grams of water and filtering, and were used without delay. A bacteriological examination of the various infusions showed that those of different origin differed not only with regard to the total number of bacteria they contained, but also with regard to the proportion of colonies of the form designated by Beyerinck† as *Bacillus radicicola*. The averages of numerous determinations of the number of bacteria per c. c. in the infusions of different soils were as follows:

	Total number.	*Bacillus radicicola.*
Pea soil infusion	1,980,000	78,000
Lupine soil infusion	156,000	None
Robinia soil infusion	880,000	78,000
Gleditschia soil infusion	340,000	40,000
Laburnum soil infusion	1,300,000	143,000

The lupine soil had been kept for several months before the infusions were made, and had become very dry. No *Bacillus radicicola* was found, and the bacteria present were all less active than those in the

* The peat proved unsatisfactory, as it decomposed, and in all experiments except the first series only half of the above amount was used.

† Bot. Ztg., 46 (1888).

infusions of the other soils. In preparing the pure cultures of bacteria from tubercles the tubercles were first washed with a weak solution of corrosive sublimate to destroy any germs on the surface, cut open with a sterilized knife, and a small amount of the tissue taken out with a platinum wire. At first only young tubercles were used, but later full-grown ones were employed with equally good results. In the inoculation the soil immediately surrounding each plant received 7 c. c. of the decoction.

First series of experiments.—In this series, peas, Robinia, laburnum, and Gleditschia were used. The plants of each genus were grown in sterilized soil, being inoculated in separate cases with soil infusions of lupine, peas, Gleditschia, Robinia, and laburnum soils, and with pure cultures of bacteria from pea and from Robinia tubercles, and in sterilized soil with a dressing of calcium nitrate or ammonium sulphate, or without the addition of nitrogen.

The results of this series of experiments show, as suggested by Hellriegel, that the extracts of different soils are quite different in their action on different leguminous plants, and the authors believe that these differences can not be accounted for, as Frank* suggested, by the difference in the number of bacteria present. In the case of Gleditschia, no symptoms of nitrogen starvation were noticed for over 2 months. The plants grew, although slowly, and produced on an average about four times as much dry matter as the original seeds contained, and in some cases a noticeable increase of nitrogen. No tubercles were formed on any of the roots, and no beneficial effects from the inoculation were perceptible.

The laburnum plants did not grow well in the soil mixture used and were harvested early. The indications were that plants of this genus respond slowly to inoculation.

The first pea plants to respond to the inoculation were those inoculated with pea extracts (either from soil or pure cultures), the change in the leaves being perceptible 20 days after the inoculation. The effects of Robinia soil extract were felt latest of all; the pure culture from Robinia tubercles met with an accident. In the case of both Robinia and peas nearly all the plants inoculated produced root tubercles and the tubercles were confined almost exclusively to those roots near the surface. The pea plants produced a much larger number than the Robinia. The roots of a single pea plant (inoculated with Gleditschia soil infusion) produced 4,572 normal tubercles.

The effects of the inoculation of Robinia were observed first where pure cultures from Robinia tubercles had been used (20 days after the inoculation) and 10 days later where Robinia soil infusion had been used. The effects where laburnum soil infusion was used were noticed about the same time, and where Gleditschia soil infusion was used about 10 days later, or 20 days after the Robinia soil infusion.

* Landw. Jahrb., 19 (1890), p. 618.

The infusions of lupine and pea soils and the pure cultures from pea tubercles showed no beneficial action up to the close of the experiment. It was found exceedingly difficult, although not altogether impossible, to cultivate Robinia in sterilized soil, under the precautions mentioned above, without the formation of tubercles. Plants inoculated after they had passed a certain stage, although they produced tubercles, failed to recover from the starvation period, and the author believes they were no longer capable of assimilating nitrogen even when the tubercles were present.

It was noticed where the inoculation of Robinia was successful that in general the amount of dry matter produced and the percentage of nitrogen in the same were larger than when the plants received a dressing of nitrogenous fertilizers instead. Thus, while the inoculated plants averaged 3.088 per cent of nitrogen, those manured with nitrogen averaged only 1.312 per cent.

The results of this series of experiments show, therefore, that in the case of peas and Robinia each kind of plants responded most readily to inoculation with extracts of soils in which a similar kind of plants had been previously grown, *i. e.* peas to pea soil extract, and Robinia to Robinia soil extract. On the other hand the Robinia soil extract when applied to pea plants was felt latest of all and the pea soil extract failed to produce any perceptible effect when applied to Robinia. The authors are forced to believe from these results that the infusions of different soils must contain bacteria which in some manner differ from each other. They believe, however, that the solution of the question must come through the study of pure cultures, as only indefinite results can be obtained with crude infusions.

While the pure cultures from Robinia tubercles were effective on Robinia plants, the pure cultures from pea tubercles, as well as the infusion of pea soil, were entirely without effect on Robinia. But the fact that the pure cultures from pea tubercles had almost no effect on pea plants rendered further trials necessary, although the authors suggest that the absence of action in the latter case may have been because the inoculation came too late for the rapidly growing pea plants.

Second series of experiments.—Peas, lupine, and beans were used, pure cultures being employed almost exclusively.

Pea plants were inoculated with pure cultures from the tubercles of peas, lupine, and Robinia, and from extracts of soils in which these plants had been grown. The plants inoculated with pure cultures from either pea soil or tubercles and from lupine tubercles produced root tubercles; the remainder failed to produce any tubercles. Those inoculated with bacteria from peas bore the tubercles on the roots of the second order; and those with cultures from lupine tubercles bore tubercles on the roots of the third order, and the tubercles were somewhat different in appearance from those where pea bacteria were used. These observations on the locality of the tubercles were verified in a second

experiment. The difference between the locality of the lupine and pea bacteria is believed to be due to a less energetic action of the lupine bacteria, and this theory is borne out by the growth of the plants in general. In repeated trials the pure cultures from Robinia soil or tubercles failed to produce any effect upon the peas. The authors believe that there can not be the slightest doubt that the pea and Robinia bacteria are different in their physiological action, and that if they do not represent different groups or varieties they at least represent separate modifications with regard to the process by which they derive their nourishment. Differences were also noticed in the growth of the colonies and the microscopical appearance of the bacteria from the two sources, the colonies of Robinia bacteria being somewhat lighter-colored than those of the pea bacteria, etc.

Lupine plants were treated with ammonium sulphate or inoculated with crude infusions of lupine soil (fresh sample) and laburnum tubercles, and with pure cultures of bacteria from lupine tubercles and soil, pea tubercles, Gleditschia soil, Robinia tubercles and soil, and laburnum tubercles. One vessel received no nitrogen or inoculation. The growth of the plants was weak in all cases. Only those plants which were inoculated with bacteria from lupines produced root tubercles, this result confirming in every way the results previously obtained with Robinia and peas. The observation made in the case of Robinia, that the tubercles were without action when formed so late that the leaves were no longer in a condition to assimilate and so recover from the starvation period, was confirmed in the case of lupine.

The object of the trial with beans (*Phaseolus vulgaris*) was to test the truth of the statement made by Frank,* that since the seeds themselves contain bacteria, beans are capable of forming tubercles, even when grown in sterilized soil, without inoculation. The plants were treated with calcium nitrate or inoculated with bean soil infusion and with pure cultures of bacteria from pea, lupine, and Robinia soils and tubercles. Two cultures remained sterile. Only those plants which were inoculated with bean soil infusion or with pure cultures of bacteria from pea soil or pea tubercles produced tubercles in any considerable number. This plant, then, presents no exception among the papilionaceous plants with respect to the formation of tubercles in sterilized soil. It was observed that where the plants were inoculated with bean soil extract or with pure cultures of pea tubercle bacteria, the root tubercles were on small roots of the third order. In most cases a root of the fourth order sprang from the tubercle, and this root often became much stronger than the root of the third order which bore the tubercle. It was also found that the roots springing from the tubercles were remarkable for the amount of crystals of oxalate of lime which they contained. The authors believe that the processes which lead to the increase of nitrogen in the plant take place in the tubercles, and that the

* Landw. Jahrb., 19 (1890).

materials in the roots of the fourth order which spring from the tubercles consist exclusively of metabolic products of the bacteria themselves. The question whether the bacteria take up and work over the free nitrogen of the air or water directly, or whether the crude nitrogen-containing materials are transmitted to them from the leaves, although the latter seems most probable to the authors, is not further discussed by them.

Other experiments.—In order that the conditions might be exactly the same for the different kinds of plants, peas, lupine, Robinia, laburnum, and Gleditschia were grown together in the same vessel. Four vessels, each containing one plant of each of the above species, were inoculated with pure cultures of bacteria from Gleditschia soil, and from pea, Robinia, and lupine tubercles, respectively; the plants in one glass remained sterile. All the plants in the same vessel were treated exactly alike. In the case of each vessel that plant did best which was inoculated with the bacteria peculiar to the tubercles of its own species. Thus, in the case of the inoculation with bacteria from pea tubercles, the pea plant far surpassed all the other plants in that glass in luxuriance of growth; where Robinia tubercle bacteria were used the Robinia did better than any other plant, etc.

The fact that in most cases the root tubercles occurred at a depth equivalent to only about one third of that to which the roots extended, seemed to indicate that the spontaneous diffusion of the bacteria in the soil takes place slowly. This would seem to explain the fact that there was no benefit from late inoculation. To test this point the following experiments were made: Six pea plants were placed in each of two sterilized vessels containing sterilized soil; one vessel contained no nitrogen and the other contained nitrogen in the form of calcium nitrate. One plant in each vessel was inoculated June 18 with 7 c. c. of extract of pea tubercles, directly on the upper portion of the root, by means of a pipette. At the time of the inoculation the plants in the nitrogen-free soil were just beginning to show signs of starvation. The inoculated plant began shortly to show unmistakable evidence of recovery. On the 28th of August the inoculated plant in the nitrogen-free soil was about twice as tall and contained nearly twice as many leaves as either of the other five plants. The effect of the inoculation in the vessel containing nitrogen, while less striking, was apparent. The indications are that the ability of these bacteria to diffuse in the soil spontaneously is quite limited. In this trial as well as in the first series of experiments, it was noticed that the pea plants which were developed by the aid of inoculation either produced no flowers, or in case they did, did not develop seeds, while those that were not inoculated and those manured with nitrogen all bloomed and some few produced seeds in spite of their less luxuriant growth. This is stated as being a further indication that the action of the bacteria in leguminous plants encourages the vegetable growth at the cost of the development

of the reproductive organs; and it is suggested that this may in many cases prove an important practical consideration, as in the case of leguminous plants grown for fodder.

Some studies were made with reference to the morphology and nature of the root tubercles of the pea. The form and character of the filaments and bacteroids were carefully studied, and subsequently the tubercles produced on the pea under the influence of lupine extracts were observed. In the latter case the filaments were just as numerous and of the same general appearance as where the inoculation was with bacteria from pea tubercles, and the bacteroids were of the form found to be characteristic for the pea. This leads the authors to assert that the formation of the filaments and the general appearance of the bacteroids is dependent, not upon the kind of bacteria causing them, but upon the plant on which they are formed. This would seem to support Frank's theory, that both the filaments and the bacteroids are products of the cell plasm of the plant rather than of the bacteria themselves. However, forms believed to be bacteroids were found, often in large numbers, in the pure cultures and especially in those of lupine bacteria. This leads the authors to agree with Prazmowski that the bacteroids proceed from the bacteria themselves. They also express the belief that the nitrogen which the plant gets by this symbiosis is very largely a product of the metabolism of the bacteria, and that only a relatively small portion is derived through the absorption by the plant of the bacteria or bacteroids.

Vegetation experiments in boxes, F. Wohltmann and H. Scheffler (*Ber. aus d. physiol. Laboratorium u. d. Versuchsanstalt d. landw. Inst. d. Univ. Halle, 7 (1887); ibid., 8 (1891)*).—In the year 1885, Dr. Wohltmann began an extensive system of experiments in the experimental garden of the Agricultural Institute of the University of Halle, the purpose of which, as expressed in the title of his descriptive memoir, was to furnish "a contribution to the testing and improvement of the methods of exact experiment for the solution of current questions regarding the treatment of soils and cultivation of plants." Certain improvements upon Wagner's method of pot experiments as then developed were attempted by Wohltmann, and the opportunity was utilized for studying the growth of plants under the action of different fertilizers in a soil of a type very common in north Germany.

Wagner uses zinc cylinders, which are placed upon small cars so as to be conveniently handled and run under a cover when necessary for protection from storm or frost. To these cylinders Wohltmann makes several objections, of which the chief are in substance that since they are exposed on all sides to air and the sun's rays, the soil in them must undergo greater changes in temperature than in its natural situation; that the surface area is not large enough; that the depth is not sufficient for normal root development; and that the water supply and drainage are not normal. To provide the desired surface area, depth, and bulk

of soil, Wohltmann used zinc boxes, 85 cm. long and about 47 cm. wide (surface area 0.4 square meter) and 1 meter deep, *i. e.* about 34 inches long, 18½ wide, and 39 deep. The zinc was protected by asphalt varnish. To secure natural temperature, the boxes were sunk in the earth so as to have the soil within and without at the same level, and plants of the same species as those grown in the boxes were also grown in the soil between them. To facilitate proper regulation of water supply from below, drainage, and collection of drainage water, a perforated zinc tube, which was coated inside and outside with asphalt varnish, was laid on the bottom of each box and covered by semicylindrical drain tile. This tube passed through the end of the box at the bottom. To the end of the tube outside the box was connected a perpendicular glass tube so that water could be introduced at will and the height of the water table maintained at any desired level and conveniently observed.

A faucet was attached to the tube at a height of 20 cm. from the bottom. By this the drainage water was collected in a graduated 5-liter flask which stood underneath. The boxes were placed on a brick foundation. To provide for getting at the drainage tubes, passages a little more than 1 meter deep were made between the rows of boxes. The boxes were filled to a depth of 23 cm. from the bottom with pure quartz sand (which thus served as subsoil), and then to within 2 cm. of the top with the soil selected for the experiment. This was a sandy loam which contained but little humus and had been cropped for 3 years without manure. The soil was taken from the field to a depth of 33 cm., *i. e.* so as to include only surface soil, and was sifted and thoroughly mixed, so that it should be of uniform character for all the boxes. Investigations were made of fineness (elutriation), water-holding capacity, and chemical composition of both sand and soil.

Seven kinds of plants were grown, barley, wheat, oats, yellow lupines, blue lupines, peas, and beans. The seed was chosen with a view to its special fitness for the experiment and was tested in germination trials. The individual seeds were carefully selected, so as to have those of each plant as nearly alike as practicable in appearance, weight, and specific gravity. They were sown at distances apart corresponding to those in the best field practice.

The fertilizing materials were furnished in nitrate of soda, sulphate of potash, and plain superphosphate, each singly and all three together. To compare the effects of phosphoric acid in different combinations, "double superphosphate" was used in some of the earlier trials, but replaced by a mixture of plain superphosphate and potash salt after trials of two successive seasons had shown that phosphoric acid had but little effect. The quantities of fertilizers were made equivalent to the largest ordinarily employed, so as to insure generous supply.

The boxes containing plants were arranged in 7 rows running east and west and 11 rows running north and south. In addition to these

were 2 in which the soil remained fallow, making the total number 79. Of the 7 east and west rows, 1 was devoted to each of the seven kinds of plants. Of 11 north and south rows, 2 were unmanured, 2 received the mixture of the three fertilizing materials, 2 nitrate of soda, 2 sulphate of potash, 2 plain superphosphate, and 1 double superphosphate in 1885 and 1886 and plain superphosphate with sulphate of potash in 1887. Each test with each plant and fertilizer was thus made in duplicate, except in the single row last mentioned. The same kind of plant was grown in the same box year after year and with the same fertilizer, except in the case of the single row referred to.

To facilitate proper distribution of the pollen of the lupines, a hive of bees was kept near the plants. Instead of a cover of wire netting, which is sometimes used to prevent the ravages of sparrows when the seeds are maturing, a *Geier* (a kind of small hawk) was kept confined by a chain close by, and for a short time strings carrying strips of colored paper were stretched over the plants. No trouble from birds was experienced, though the *Geier* have in other instances not sufficed to frighten the sparrows away.

The observations on the plants harvested, which are reported in detail, include weight of whole crop and of seed and straw (including chaff) separately; the number, length, and weight of stems; weight of leaves and of ears or pods from which the seeds had been removed; number and weight of ears or pods with seed, and weight of seed per ear or pod, large and small; averages per plant for total weight, and weights of seeds, ears or pods, leaves, and stem separately; and calculated yield of seed, straw, and whole crop per hectare. The weights as given refer to air-dry material. Determinations were made of the percentages of nitrogen, ash, potassium oxide, and phosphorus pentoxide in the whole produce and in the seed and straw separately, and from these are made calculations of the amounts contained in the produce per experiment and per hectare. No determinations were made of the amounts of moisture, so that the figures do not show the actual composition of the plants, *i. e.* of water-free substance. The samples analyzed were taken from the boxes of only 1 of the 2 duplicate rows of plants which received like treatment. Hence while the data for quantity of air-dry material represent averages of two duplicate trials, those for chemical composition represent only one of the trials.

Barometric pressure, rainfall as shown by rain gauge, temperature of air, and temperature of soil at the surface and at different depths of the soil between the boxes, as indicated by thermometers, were observed and recorded during the growing period from April to September. Determinations of evaporation of water by the method of H. Wild of St. Petersburg were attempted, but found unsatisfactory and given up.

For study of the water supplied to the soil, determinations were made of the amount of water, (1) in the soil at the beginning as found by moisture determinations in a sample; (2) supplied by rain as measured

by the rain gauge; (3) supplied artificially, either by surface watering or by watering from below, *i. e.* pouring water into the glass tube; (4) removed as drainage water through the tube. The height of the water table (ground water), which was occasionally raised by pouring water into the tube, was also noted. By adding the amounts supplied by rain and artificial watering and subtracting from this sum the amount removed by drainage, allowance being made for change in the height of the water table, an estimate was made of the amount which escaped by evaporation from the surface of the soil and by transpiration through the plant. To make the estimates accurate, determinations of the moisture at the end as well as at the beginning of the experimental period would have been necessary, but such determinations were not convenient, and it was thought that the error would not be large enough to rob the estimate of value as a general indication of the amounts of water which escape from plant and soil under similar conditions in ordinary field culture.

In a number of the specimens of drainage water determinations were made of the proportions of nitrogen, phosphoric acid, and potash.

Dr. Wohltmann began the experiments in 1885, repeated them in 1886, and was then compelled by illness and absence from Germany to leave them. They were continued in 1887 by Dr. H. Scheffler. But the labor involved was large, and, what was still more serious, leaks appeared in a number of the boxes, thus interfering with the studies of moisture supply and drainage, and the investigation was therefore given up. The boxes of soil have since been used for the study of diseases of plants, to which the experimental work of the institute is especially devoted and for which these arrangements are well adapted. The experiments of 1885 and 1886 were reported by Dr. Wohltmann in 1887. Those of 1887, with final conclusions, have just been published. The whole memoir, which fills some 240 quarto pages of text, is supplemented by numerous and extensive tables of numerical details.

Results of the experiments.—The experiments with beans and lupines were unsuccessful, partly because of diseases for which no adequate remedy was found and partly for reasons which could not be explained. The lupines developed very unequally in the duplicate boxes. Dr. Wohltmann attributes this to individual differences in the plants and thinks that the lupine can hardly be regarded as a suitable plant for such experiments as these (in which relatively few plants are used for each trial) until means shall have been found, by studies of the seeds or otherwise, to secure like plants for all the trials of the experiments. In the compilation of average results the beans and lupines were left out of account.

The experiments with barley, oats, wheat, and peas were in the main successful, though in a few instances the plants were injured by diseases. In several cases, in which the germinating seeds or very young plants were thus affected, second sowing was resorted to. The cases in

which the injury was deemed sufficient to impair the validity of the results were very few.

The total yields in the successful trials, especially where fertilizers were used, were for the most part larger than are usually obtained in field practice, even with the best treatment—a circumstance easily explained by the natural richness of the soil, the abundant water supply and manuring, the careful selection of seed, and thorough cultivation.

Since the results are of less consequence for the purposes of this abstract than the method, they may be recapitulated very briefly:

(1) The effect of the phosphates and potash salts upon the total yield, the proportions of the different parts, and the chemical composition of the plants, was not especially marked, except that in the experiments with oats, especially the first season, the total yield was somewhat larger with these fertilizers than without them. It was evident that the soil, although it had been cropped for several years without manure, contained a considerable supply of available phosphoric acid and potash.*

(2) With nitrate of soda, however, the total yield of the barley, oats, and wheat was considerably increased, though the ratio of grain to stalk was not materially affected. The total yield of peas, on the other hand, was not notably increased, while the ratio of the seed to the total weight of the plant was less and the proportion of stem and leaf was greater with the nitrate of soda than without it. The soil supply of nitrogen evidently did not suffice for full growth of the cereals and they responded to the nitrogen of the fertilizer. The peas, however, refused as usual to respond to nitrogen, that is to say, the total product was not increased, though there was a tendency to increase of stem and leaf and decrease of seed. The principal effect of the fertilizer seemed to be in causing development of the vegetative rather than the reproductive organs.

(3) The increase of yield of the cereals with nitrate of soda was most marked with the barley and least with the wheat, as appears from the following tabular statement:

Yield (weight of produce) with nitrate of soda, the yield without manure being taken as 100. Average of three seasons.

Cereal.	Grain.	Straw.	Whole plant.
Wheat	138.9	137.3	138.1
Oats	153.1	140.2	144.3
Barley	163.0	157.3	159.8

* The necessity of avoiding excess of available plant food in soils in which experiments on the action of fertilizers are to be made, is here illustrated. Even soils supposed to be well "worn out" often have large supplies of the very substances the action of which in the fertilizers is to be tested. In some of the German stations a regular system is adopted for preparing soils for such experiments by growing plants upon them without manure for several successive seasons.

The percentages of protein were in general decidedly larger in the plants which had nitrate of soda than in those which were unmanured. Exceptions to this rule, however, were found with the cereals in 1886, which season was wet, while in 1885 and 1887 it was relatively dry. The average daily rainfall during the growing months of May, June, and July was, in 1885, 1.86 mm; in 1886, 2.66 mm; in 1887, 1.73 mm. The following figures give the differences found by subtracting the percentages of protein in the unmanured plants from those in the corresponding plants treated with nitrate of soda. It is to be remembered, however, that the analyses were made of single and not of duplicate samples, and that the figures in this table, as in the one just preceding, refer to the air-dry substance. It is not impossible that determinations of water and calculations of weight and composition of water-free substance would have made some changes in the relative proportions, though it seems hardly probable that the tenor of the results would have been materially altered.

Increase (+) or decrease (−) in percentages of protein in produce with nitrate of soda as compared with no manure.

Cereal.	1885. Relatively dry.		1886. Relatively wet.		1887. Relatively dry.		Average of three seasons.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
Barley	+2.6	+0.6	+0.2	−0.1	+2.6	+0.9	+1.8	+0.5
Wheat	+2.6	+0.8	−0.4	+0.7	+3.2	+1.9	+1.8	+1.1
Oats	+2.1	+0.7	−0.9	−0.3	+1.5	+0.4	+0.9	+0.3
Peas	+2.8	+1.7	+2.4	+0.8	+2.8	+0.4	+2.7	+1.0

(4) The percentage of ash was apparently not affected by the phosphate and potash salt in any of the plants nor by the nitrogen in the peas, but in the cereals it was lower with the nitrate of soda than without it.

(5) As regards the relative development of the different organs, the water supply seemed to have more influence than the fertilizers. When the rainfall was large the stems and leaves were developed at the expense of the seed.

(6) The amount of water which escaped by evaporation from the soil and by transpiration through the plants during the growing season, varied greatly with the seasons. From the observed results Dr. Wohltmann has made computations of what he regards as normal quantities in liters per plant and per kilogram of dry substance. These, with the estimated amounts per hectare in cubic meters for each of the three seasons, are given in tabular form herewith. The quantities are for the periods of vegetation of a little over 3 months.

Amounts of water evaporated from soil and plant during the growing season.

	Barley.	Wheat.	Oats.	Peas.	Fallow.
Estimated normal amounts—	*Liters.*	*Liters.*	*Liters.*	*Liters.*	*Liters.*
Per plant	2.0	1.6	2.7	5.6	....
Per kilogram of air-dry plant	350	400	350	300	....
Estimated amount per hectare—	*Cubic meters.*	*Cubic meters.*	*Cubic meters.*	*Cubic meters.*	*Cubic meters.*
Season of 1885	2.463	2.702	2.666	2.245	2.075
Season of 1886	3.475	3.625	3.625	3.575	2.800
Season of 1887	2.900	2.975	3.050	2.000	2.775

The experimental method.—Despite the mishaps in these particular experiments, Wohltmann regards the method as having proved itself fitted for its purpose.

(1) The chief difficulty was caused by leaks. The sides of the boxes next to the passageways being subject to outward pressure from the soil within and not protected by corresponding lateral outside pressure, bulged out and pressed against the upright glass tubes. The joints of the latter were thus loosened and in some cases the tubes were broken. This and defective stoppers were the causes of the leaks. A simple arrangement is proposed for remedying these difficulties and providing at the same time for drawing off the drainage water at the bottom instead of at a point 20 cm. above the bottom, as was done in these experiments. This would also allow better regulation of the height of the water table.

(2) One essential test of the value of the method is the agreement of duplicate trials as shown by the amount of produce. In each of the three seasons' experiments four kinds of plants—barley, wheat, oats, and peas (the trials with beans and lupines were left out of account in the comparison because of failure of a number of plants, as above stated)—were grown, each in 5 duplicate series with different fertilizers or unmanured. This made for each year 40 single or 20 duplicate trials. In these 60 cases there were 3, all with peas the second season, in which the plants of one of the duplicates were so defective as to make the results unsatisfactory. The agreement of the duplicates in the other 57 cases was computed by taking the larger yield of the 2 duplicates in each case at 100 and the smaller at the corresponding number, and calling the difference between these two numbers the difference of duplicates in per cent. This percentage difference of duplicate trials averaged in 1885, 3.4; in 1886, the moist season, 5.7; in 1887, 3.8; and in all the 57 cases of the three seasons together, 4.3 per cent. It exceeded 5 per cent in 16 cases, of which 8 were in 1886, and exceeded 10 per cent in 7 cases, of which 5 were in 1886. The differences of over 5 per cent did not occur in the same pairs of boxes in 2 different years in more than 2 cases, and in only 1 of these did the differences appear in 2 successive years.

It was thus clear that these differences in yield of duplicates were not due to differences in soil or any other constant factor. The inference

is that they are to be ascribed to differences in the productive energy of the individual plants. Here, in Wohltmann's judgment, lies the chief difficulty in the way of exact experimenting with plants on a small scale. The individuality of the plants is the one factor which is beyond control. The only way to avoid its disturbing influence is to increase the number of plants and take the average results. It is to be noted, however, that the variations from the mean of the duplicates, which would be only about one half the above percentages, average only 2.2 per cent, that they exceed 5 per cent in only four cases, and that they reach only 7.7 in the worst case of all. This range of probable error is not regarded by the author as sufficient to seriously affect the value of experiments for ordinary purposes, and hence in this respect the method is regarded by him as satisfactory. Boxes of the size of those used by Wohltmann, with 0.4-meter area, have the advantage over Wagner's smaller cylinders that they hold more plants, and thus decrease the error due to difference of individuality of plants.

As a means of avoiding the difficulty of disagreement of duplicates, Wohltmann urges the importance of several parallel trials—triplicates at least, and more if convenient. Another advantage of the larger number is that if the plants in one box are injured the experiment is not spoiled.

(3) Wohltmann claims as further advantages of the boxes sunk in the earth as compared with Wagner's small cylinders above the surface of the soil, that the conditions are more nearly normal; the observations of drainage water are valuable; and the time, labor, care, and confinement required of the experimenter are not half as large. [The reason for the last-named difference is that Wagner's pots have to be weighed very often, in the time of rapid growth of the plants once or even twice a day, in order to determine the amount of water which must be given to keep the soil properly moist, and that the attendant must be constantly on hand to put the plants under cover when a storm is imminent, while in Wohltmann's boxes the water supply can be regulated by keeping the water table at the desired level, and no constant attention is otherwise required.] On the other hand, Wagner's plan of keeping the pots on small platform cars beside a glass house, into which they are easily run, gives very valuable protection against frost and storms, *e. g.*, severe rain or hail, which may sometimes ruin a whole season's work.

(4) While Wohltmann recognizes the incompleteness of our present methods for physical and chemical studies of the soil, he still urges their great importance for investigations of this class.

In conclusion, the author calls attention to the usefulness of the boxes described by him for educational purposes. They offer a very convenient means for demonstration of experiments, and might be advantageously used by agricultural schools, especially those which have not adequate field and garden area.—[W. O. A.]

Plat and box experiments at the Dresden Experiment Station for Plant Culture.—In connection with the preceding article a description of the arrangements made for vegetation experiments at the station for agricultural and horticultural plant culture in Dresden, Saxony, will be of interest as an illustration of the way in which a new station in Germany, with the fruits of large experience but only limited amounts of money at its disposal, utilizes the teachings of that experience to secure the best results.

The station was organized April 1, 1890, at the solicitation and in the special interest of practical farmers and gardeners, and is just now (autumn, 1891) completing its arrangements for experimental work. Its annual income for current expenses, exclusive of land, buildings, and outfit, is about $3,000. Its energy is to be devoted to inquiry in vegetable production, and as the neighboring station at Tharand, which has been under the direction of Professor Nobbe for nearly a quarter of a century, is engaged in more abstract researches in vegetable physiology by the methods of the laboratory and the greenhouse, the Dresden Station will give itself to investigations on the growth of plants in natural soil, thus imitating more closely the conditions of practical culture. The agricultural division of the station, which is under the charge of Dr. B. Steglich, proposes experiments with different crops, on several kinds of soil, for the study of the merits of different varieties of plants, the effects of fertilizers, and the gains and losses of plant food by the soil. It recognizes the value of field experiments, but wisely arranged to have them made in different places in Saxony by intelligent farmers under its direction. The somewhat limited area of land at the station is thus left free for experiments on a smaller and more accurate scale, for which purpose it is ample. The station is being well equipped with buildings, greenhouses, and laboratories, and the agricultural division has 2 hectares (about 5 acres) of land devoted to various experiments with plants. The special interest for our present purpose is in the arrangements for plat and box experiments.

It was felt desirable to prosecute certain experiments upon the growth of plants on the kinds of soil most common in Saxony, and to make them as accurate as possible. For this purpose the upper stratum of soil of a certain area of the station land is being removed and replaced by soils of the desired kinds. Soils of five typical classes have been chosen for the purpose. They are designated by the terms, heavy clayey, loamy, calcareous, light sandy, and humous. For these different soils separate lots are provided. Each lot is divided into ten long, narrow plats, each plat being 25 meters long and 4 meters wide and containing 10 ares. The plats are separated by strips 1 meter wide and around the border of the lot is a path of the same width, so that the whole lot is 51 meters long and 27 meters wide, with the plats running across it from side to side. The clayey, loamy, and sandy soils are obtained near

the station, so that the cost of transportation is small. The others had to be brought from a distance. The surface soil is used in each case. In preparing each lot for experiment the original soil and subsoil are removed to the depth of 1 meter. At this depth the natural subsoil is sandy and pervious, and apparently uniform over the whole experimental area, so that it seems reasonably certain that the drainage and water supply from below will be alike throughout. The space thus excavated is then filled with the imported soils. These are very thoroughly mixed, shovelful by shovelful, so that each lot is uniform in physical and chemical characters. Two lots are to be devoted to the loam, on account of the prevalence of soils of this class in Saxony and its consequent importance for experiments. For the calcareous and humous soils, which have to be brought from quite a distance, one half a lot or five plats for each are used. To each of the other kinds of soil one lot is to be devoted.

By this means it is hoped to secure uniform conditions of temperature, moisture, and chemical and physical character of soil for all the plats of each type of soil.

To protect plants at the time of the ripening of the seeds from the depredations of sparrows, which are very numerous in the locality, it is proposed to stretch wire netting over the lots. The same arrangement is planned for the box experiments to be described beyond. An attempt to frighten the birds away by a bird of prey confined by a chain near by, did not prove successful.

Such an arrangement as this is fitted for tests of fertilizers, methods of planting or tillage, or varieties of plants. The first experiments here are to be tests of varieties of wheat, which is now a very important subject for farming in Saxony.

But plat experiments, however carefully planned, do not entirely suffice. Even if the conditions of soil, subsoil, temperature, and rainfall are uniform there is no way of measuring or controlling the supply of moisture. Other important questions, such as the gain and loss of plant food with different plants and under different methods of treatment, can not be accurately studied in this way. To facilitate such investigations the station had recourse to box experiments.

In the language of Dr. Steglich, who has supplied the data for this account of the plans for experiments at Dresden,—

For tests which require scientifically exact installation and the control of certain conditions of growth, a system of vegetation boxes is provided. These are filled with the soil which is to be experimented with and placed in the ground in rows. Each row represents a series of experimental trials. The soil between and around the boxes will bear the same kinds of plants as that within them, so as to secure uniform growth. Thus each box represents an entirely isolated portion of the whole experimental area. * * * In the present state of experimental inquiry an arrangement of this kind, especially in the light of what has been done by Wolff and Wagner, is really indispensable wherever the purely scientific results of laboratory investigation are to be applied to practice, or wherever exact experiments are to be made.

In planning the boxes for experiments, Dr. Steglich studied carefully the plans which had been followed by Wolff, Wagner, Hanamann, and others, and endeavored to improve upon them. In order to make the area and depth of soil sufficient for normal growth of a considerable number of plants, it was decided to have the boxes 1 meter long, wide, and deep (inside measure). It was essential that they should be very strong and durable and not liable to be cracked by frost or disintegrated by the gases and liquids of the soil and the roots of the plants; and, finally, they must be water-tight. Zinc it was feared would hardly fulfill these conditions. Iron would rust unless it was covered by some enamel, and this was found to be hardly feasible for vessels of the desired size. Glazed earthenware would be excellent, but the information from manufacturers as to the feasibility of making such large vessels was such as to discourage the attempt to get them. A preliminary trial was made with earthenware tiles, but they were unsatisfactory on account of the number of joints to be filled. Another trial was made with glass plates set in cement. The boxes thus constructed and placed in the ground stood the severe winter of 1890–91 very well, and these materials were finally selected. The boxes as made are really of cement lined with glass. The plates of glass 1.3 cm. thick were put together in a cubical box, which serves as a mold, and the cement was cast around them. The thickness of the cement is about 8.7 cm., so that cement and glass together make the whole thickness 10 cm. The joints of the glass are carefully covered with red lead putty to insure more perfect closure. To provide for outflow of drainage water and its collection for measurement and analysis, as well as for inflow of water for moistening the soil from below, an opening is made through both cement and glass close to the bottom on one side, which may be called the front of the box. Into this opening a glass drainage tube is inserted horizontally. Inside, on the bottom of the box, a perforated semicircular drain tile is laid from the opening to the opposite side. The box is sunk in the ground with its bottom resting upon a foundation of concrete 20 cm. thick, and its top level with the surface of the surrounding soil. In filling the boxes a layer of gravel is laid upon the bottom, and on this is placed a layer of sand which reaches to a height of 20 or 25 cm. On the sand, which serves as a pervious subsoil, rests the soil which reaches to the top of the box. The soil selected for the experiment is carefully sifted and thoroughly mixed so that the portions in the different boxes shall be as similar in character as possible.

Twenty boxes are placed in four equal rows, with passages between the first and second, and the third and fourth rows. These passages are sunk in the ground to a depth of 1.8 to 1.9 meters. They are 1.5 meters wide and are faced on the sides and ends by a brick wall. Each of the two passages has a fall of 10 cm., allowing water to flow to the lower end, where it runs through apertures in the wall into a bed of gravel outside especially provided to receive it. The two passages open into

a third of like depth and 1 meter wide, into which a stairway descends from the level of the ground outside. The passages are closed at the top by tarred planks which are covered by a layer of sand. The boxes of each row are separated from the passage wall and from each other by spaces 0.5 meter wide. The rows of boxes between the two passages are separated by a space 1.2 meters wide. These spaces are filled with soil. Thus each box is surrounded on all four sides by earth. The glass drainage tube which comes from the bottom of the front side of the box is covered with an iron tube and projects through the outer soil and the brick wall of the passage into the passage itself. Here it is joined by well-devised rubber and brass connections to a perpendicular glass tube, which may be called a supply tube, and through which water can be poured for watering the soil from the bottom. A small glass tube, projecting upward into this supply tube from the bottom, serves to remove the drainage water. It can be raised or lowered at will, so as to have the upper end at the level at which the water table in the box is to be maintained. If by reason of heavy rain the water of the soil in the box is increased so that the water table would rise above this level, the excess runs off as drainage water. If on the other hand the soil gets dry and the level of the water table is lowered, it is easily raised by either pouring water on the surface of the soil or by introducing it through the supply tube. The height of the water table can be seen at any time in the supply tube, which serves as a gauge.

The boxes with the passages and stairway are surrounded by a strip of lawn and inclosed by a wire fence, the whole inclosure being some 18 meters long and 14 meters wide.

The cost of each of the boxes was, for glass $15, setting in cement and transport to the station $13.25, drainage and supply tubes and setting $2.50, drain tiles $1, total $31.75; or for the 20 boxes, $635. To this must be added the cost of digging, setting the boxes, masonry, inclosing, etc.—about $250. Other expenses will probably bring the whole cost to not far from $1,000 for the completed plant for box experiments.

Close at hand are appliances for meteorological observations, including rain gauge, barometer, psychrometers, and air and soil thermometers. The soil thermometers are placed on the surface of the soil and at depths of 0.02, 0.05, 0.15, 0.25, 0.50, and 1 meter. The underground thermometers are inserted horizontally into the soil through a wall of a passage 1.5 meters deep, specially sunk into the ground for the purpose. The bulbs reach in to a horizontal depth of 0.5 meter, except in the case of the two lowest, which extend to lateral depths of 0.75 and 1.25 meters, respectively. The scales reach outside, so that the tridaily readings can be made with the greatest convenience.

The station at Tharand, with which the one at Dresden is closely affiliated, is engaged in the study of the action of bacteria in the assimilation of the nitrogen of the air by plants. In the division of

labor between the two, the Dresden Station has more to do with the application of the results of abstract inquiry. Accordingly for some time to come the box experiments are to be devoted to the study of the accumulation of nitrogen in soil in which leguminous plants (in this case lupines) are grown. The purpose is to make an accurate practical test of the teachings of late experimental inquiry regarding the acquisition of atmospheric nitrogen by the aid of bacteria. Two kinds of soil are to be used, one sandy, the other a loam, each in ten boxes. As the purpose is to investigate as thoroughly as may be the changes in nitrogen content of the soil in the presence of the plants, it is desirable to use soil in which no plants have grown. Accordingly in taking the samples for experiment the surface soil is removed as far down as the roots of the plants upon it extend and the soil below is used. For trials with each soil two rows of boxes, with five in each row, will be used. One row will be treated with extract from a soil in which lupines have grown, while the other will be left without this treatment, in order to observe the effects of inoculation, which has been lately observed to produce such remarkable effects upon the growth of legumes and the acquisition of nitrogen. Analyses of the soil will be made at the outset and from time to time during the progress of the research, and the amounts of water supplied and removed, the composition of the drainage water, and the amounts and composition of the produce will be determined. The data thus obtained, together with the meteorological and other observations made in connection with the experiments, will give the desired statistics of the gain and loss of nitrogen. If the investigation meets with the success which is hoped for, it will throw light upon one of the most important problems in agricultural science.—[W. O. A.]

Concerning the fermentation of tobacco, E. Suchsland (*Ber. d. deut. bot. Ges., 9 (1891), pp. 79–81*).—This is a preliminary report of investigations made by the author under the personal direction of Professor Zopf. The author explains that a very important part in the curing of tobacco is its fermentation, which occurs during the process known as bulking. The cured tobacco is packed closely together in large piles, and after a longer or shorter time, depending upon the amount of moisture the tobacco contains, the mass heats, the tobacco is said to "sweat," and the aromatic and other compounds which contribute to the taste and odor of the leaf and give it tone, are formed. It was to study these changes and to discover if possible the organisms believed to be the cause of the fermentation that the author made the investigations here reported. The results of his work, which are only given in brief, he believes to be of considerable practical interest. Tobacco from Havana, St. Domingo, Kentucky, Brazil, Turkey, Greece, Russia, Alsace-Lorraine, and other parts of Europe was studied, and in all cases large quantities of bacteria were found on the fermenting material, although the number of forms was small—usually only two or

three on each sort of tobacco. When pure cultures of the bacteria peculiar to any single sort of tobacco were used for inoculating tobacco of another sort, they induced the same taste and aroma as they had in the tobacco from which they were derived. Positive results were secured in every such trial.

The author therefore believes that the process of fermentation is one of much greater importance in improving the quality of tobacco than has previously been conceded. Up to the present time the improvement of the quality has been sought particularly in the improvement of the method of culture, and in the introduction of the choicest varieties; but this has been only partially successful since the forms of bacteria inducing the most advantageous fermentation, were not imported with the seed. His results all go to show that tobacco of poorer quality may be very greatly improved in quality by inoculating with forms of bacteria common to the choicer sorts; and he claims that he has repeatedly so changed the quality of domestic tobacco by regulating the fermentation that competent judges were unable to recognize it. Further communications are promised as to the forms of bacteria.

Regarding the products which the separate forms of bacteria build, definite conclusions are not yet reached; but the author is inclined to believe that among other things a change of nicotine to nicotine-camphor takes place during the fermentation.

At what degree of acidity does cows' milk curdle on heating? W. T. Thorner (*Chem. Ztg.*, 15 (1891), p. 1108).—The method employed for determining the acidity of milk was as follows: Ten c. c. of the milk to be tested were diluted with 20 c. c. of water, a few drops of phenolphthalein added, and the solution titrated with deci-normal potash solution. The number of tenths of a c. c. of alkali required for neutralization was taken as the degree of acidity of the milk, each tenth of a c. c. representing one (empirical) degree. As indicated by this method, the degree of acidity of the market milk of the city of Osnaburg was found to range as follows: At time of purchase (3 to 4 hours after milking) 12°–16°, 6 hours later, 14°–25°, 24 hours later 17°–60°, and 48 hours after this 30°–100°. The more rapidly the milk was cooled after the milking and the cooler it was kept, the more slowly did the acidity develop, and the reverse (except where kept at a temperature above blood heat). In these tests sunlight and darkness seemed to have very little effect on the rapidity of souring.

To determine the degree of acidity at which milk would be coagulated by heating to boiling, the author made a large number of tests of milk kept from 2½ to 28 hours in a cellar in the sunlight and in the dark. The results all pointed to 23° as the lowest degree of acidity at which milk would curdle on heating. Assuming 20° to be the limit of acidity allowed, he suggests that milk could be rapidly and simply tested by adding 2 c. c. of deci-normal alkali, and a few drops of phenolphthalein to 10 c. c. of well-mixed milk diluted to 30 c. c. with water.

If a red color is produced, even though a weak one, the milk will not curdle on boiling.

Canadian experimental farms, Annual Report, 1890 (pp. 314) (*Report of Director, W. Saunders*, pp. 5–53).—A summary is given of the report of experiments in early and late seeding of barley, oats, and spring wheat, recorded in Bulletin No. 8 of the Central Experimental Farm (see Experiment Station Record, vol. II, p. 520). The distribution of seed of oats, barley, wheat, peas, and corn in 1890 is described, and reports from persons who experimented with the seeds are summarized. The total number of samples distributed was 12,353 to 5,896 applicants. Notes and tabulated data are given for tests of 16 varieties of oats on small plats and 25 on large field plats; of 11 two-rowed and 5 six-rowed varieties of barley on small and large plats; 15 varieties of spring wheat on small plats, 5 on large plats, and 9 planted in rows 2½ feet apart; 9 varieties of winter wheat; 4 of winter rye; 1 of spring rye; 5 of peas; 17 of turnips in one series and 22 in another; 21 of mangel-wurzels; 14 of sugar beets; 25 of carrots in one series and 24 in another; and 94 of potatoes. Twelve hundred and forty-five samples of seed of grain, grasses, clover, vegetables, etc., were tested at the Central Experimental Farm in 1889 and 1890. The results, as stated in a table, show a wide variation in the average vitality of different kinds of seed. There is an account of the results of the growth of two-rowed barley from seed imported by the Government of Canada, taken from Bulletin No. 9 of the Central Experimental Farm (see Experiment Station Record, vol. II, p. 520). Information regarding experimental work in forestry on the western plains of Canada is given in a paper by the Director, which was read at the meeting of the American Forestry Association at Quebec, in September, 1890. Accounts are given of visits made by the Director to the different branch experimental farms of Canada, and a financial statement for the several farms for the fiscal year ending June 30, 1890. The number of letters received during 1889 was 6,864; during 1890, 19,806; number of bulletins and reports sent out during 1889, 41,584; during 1890, 218,129. The mailing list of the Central Experimental Farm is 20,600, in addition to a special dairy list of 4,000.

Report of Agriculturist, J. W. Robertson (pp. 54–68, figs. 51).—This includes an illustrated description of the experimental dairy building and the piggery erected at the Central Experimental Farm. Accounts are given of the swine and cattle of different breeds kept at the farm, with details regarding the rations fed to them.

Report of Horticulturist, J. Craig (pp. 69–102).—Under the head of orchard fruits, notes are given on varieties of apples, pears, plums, cherries, and apricots grown at the Central Experimental Farm, with special references to Russian varieties of apples and pears; and also notes on varieties of grapes, strawberries, raspberries, blackberries, currants, and gooseberries; and on 22 varieties of cabbages, 7 of celery,

12 of sweet corn, 10 of lettuce, 14 of peas, 13 of radishes, and 7 of tomatoes. An account is given of the distribution of different varieties of seedling forest trees and also of tree seeds. Experiments with fungicides for apple scab (*Fusicladium dendriticum*) are briefly recorded, and tabulated data are given for an experiment with fungicides on apple leaves, with a view to ascertaining (1) the greatest strength in which the different fungicides can be applied without injury to the leaves; (2) the effect on leaves of the copper solutions with or without ammonia; and (3) the effect on the leaves of a fungicide combined with Paris green. The Wealthy variety was used in this experiment. Copper sulphate, used in the proportion of 8 ounces to 22 gallons of water with or without ammonia or Paris green, caused much injury to the leaves, while copper carbonate, 1½ or 3 ounces to 22 gallons of water, caused little injury.

Report of Chemist, F. T. Shutt (pp. 103–153).—This report includes popular discussions of the physical properties and chemical composition of soils, the value of mud, muck, peat, marl, gypsum, wool waste, gas lime, and lamb's quarters (*Chenopodium album*) for fertilizing purposes, and analyses of the same; analyses of foods and feeding stuffs, milk, apple tree leaves, well water, and foundation comb; a study of the effects of solutions of copper sulphate, iron sulphate, and "agricultural bluestone" on the vitality of seed wheat; and an article on spontaneous combustion.

Fodders (pp. 116–133).—A popular discussion is given on the constituents of feeding stuffs, coefficients of digestibility, and nutritive ratio of food ingredients; a description of different feeding stuffs; analyses of linseed meal, cotton-seed meal, germ meal, Golden Tankard mangel-wurzel, lamb's-quarters, silage, and of corn, redtop, June grass, timothy, and tall fescue at different stages of growth; the percentage of dry matter and of starch in 80 varieties of potatoes as calculated from the specific gravity by the use of Holdefleiss's tables; and analyses of 64 samples of sugar beets raised in different localities in Canada. The tests of the samples of sugar beets show that 60 per cent contain over 12 per cent of sugar, and 38 per cent over 13 per cent of sugar.

> The averages as they stand indicate a very fair factory beet, and, all things being considered, compare well and favorably with those of other countries in which beet sugar is manufactured. Sufficient work has been done to indicate that both as regards yield per acre and richness in sugar, with a more careful cultivation, sugar beets may be raised in many parts of Ontario fully equal to those of Europe and the United States.

Remarks are also made on the culture of the sugar beet and on the value of the diffusion chips for feeding purposes.

Milk (pp. 133–140).—Analyses are given of 93 samples of milk of Jersey, Holstein, Ayrshire, Aberdeen, Angus, and Shorthorn cows during short periods, together with the rations fed.

Composition of apple tree leaves (pp. 141–146).—This is from an article on this subject read by the author at the Dominion Fruit Growers'

convention at Ottawa in February, 1890. The composition is given ot the leaves of Duchess of Oldenburg, Tetofsky, Wealthy, Fameuse, and Northern Spy apple trees, collected May 25 and September 20, and from these analyses is calculated the amount of nitrogen, phosphoric acid, and potash contained in 1,000 pounds of fresh leaves from each variety. The averages of the 5 varieties at each gathering are given in the following table:

Analyses of apple tree leaves.

	In green leaves.		Nitrogen in organic matter.	In 100 parts of ash—						Fertilizing ingredients in 1,000 pounds of leaves.		
	Moisture.	Ash.		Phosphoric acid.	Potassium oxide.	Calcium oxide.	Magnesium oxide.	Ferric oxide.	Silica.	Nitrogen.	Phosphoric acid.	Potassium oxide.
	Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Lbs.*	*Lbs.*	*Lbs.*
Gathered May 25	72.36	2.33	2.94	10.47	10.82	17.40	9.77	1.49	1.07	7.42	2.45	2.52
Gathered September 20	60.71	3.46	2.48	5.82	11.63	27.91	4.81	1.41	1.14	8.87	1.94	3.92

Effect of solutions of copper sulphate, iron sulphate, and "agricultural bluestone" on the vitality of seed wheat (pp. 146–148).—In this test Red Fife wheat, containing 97.5 per cent of seed capable of germinating, was used. The agricultural bluestone was found to consist of 69.3 per cent sulphate of iron and 30.7 per cent sulphate of copper. The solutions were prepared by dissolving 1 pound of the material in 8 gallons of water. In the first experiment seed was soaked in each of these solutions during 36 hours, and at the end of that time was sown in earth in the conservatory to determine its percentage of vitality; in the latter experiment the wheat was merely sprinkled with the different solutions, allowed to dry, and sown at once. The results lead the author to conclude that—

(1) A solution of sulphate of copper of the strength of 1 pound to 8 gallons of water has the effect of destroying a number of wheat germs, and that even when the sulphate of copper is present only to one third of this amount (as it is in the agricultural bluestone) the injurious action is still strongly marked.

(2) A solution of sulphate of iron of the same strength has eventually but little destroying action on the wheat seed, though at first the plants from seed so treated have their growth somewhat retarded.

(3) The length of time that the sulphate of copper is in contact with the seed determines, to a large extent, the amount of damage done to the vitality of the germ. If sprinkling be sufficient to destroy the smut spores the grain should not be left in contact with the solution longer than necessary, but dried and sown at once.

The results of tests made to determine the value of solutions of sulphate of iron, sulphate of copper, and agricultural bluestone used in the strength given above for preventing smut in wheat "seem to indicate that none of the solutions tried are efficacious in preventing the development of loose smut." Experiments on this subject are to be continued.

Foundation comb (pp. 150, 151).—Analyses are given of three samples of foundation comb sent to the station to be tested as to purity. In addition to the analyses, directions are given for detecting adulterations of honeycomb.

Report of Entomologist and Botanist, J. Fletcher (pp. 154–206, plates 9, figs. 7).—The entomological portion of the report contains original and compiled notes on the American frit fly (*Oscinis variabilis*), cabbage maggot (*Anthomyia brassicæ*), diamond-back moth (*Plutella cruciferarum*), Mediterranean flour moth (*Ephestia kühniella*), pea weevil (*Bruchus pisi*), strawberry weevil (*Anthonomus musculus*), and Vancouver Island oak looper (*Ellopia somniaria*). The differences in the effects of the attacks of the frit fly, Hessian fly (*Cecidomyia destructor*), and wheat stem maggot (*Meromyza americana*) are stated and the several stages of these insects are differentiated. Successful experiments were made with white hellebore as an insecticide for the cabbage maggot. A solution of 2 ounces of hellebore and 3 gallons of water was applied with a syringe around the roots of cabbage plants from which the surface soil had been removed by hand. Kerosene emulsion proved the most satisfactory remedy for the cabbage plutella. The treatment of the seed of peas with bisulphide of carbon is generally adopted by Canadian seedsmen. For the strawberry weevil it is suggested to try covering the beds after the formation of the flower buds with newspapers or strips of cloth held down at the edges with earth. These should be put on at the first appearance of the beetles and kept on until the flowers have expanded. The Vancouver Island oak loopers, which defoliate oaks in the vicinity of Victoria, appear in the larval stage about the middle of August, pupate near the end of that month, and begin to emerge as moths by September 20. In 1890 they appeared in very large numbers. The insect passes the winter in the egg state. The eggs may be destroyed by spraying the trunks of the trees in early spring with kerosene emulsion. The larvæ may be killed with the arsenites. *Ichneumon cestus, Pimpla* sp., and a Tachina fly were observed as parasites on the oak looper.

Under the head of botany are given brief notes on 72 species of grasses which are being tested at the Central Experimental Farm, and lists of a number of species of native and foreign grasses with which some experimental work is being done. The nine plates which illustrate this portion of the report are taken from the publications of this Department.

Report of Poultry Manager, A. G. Gilbert (pp. 207–229).—Accounts are given of the methods followed in the management of various breeds of hens at the Central Experimental Farm. An experiment in setting hens on nests placed on dry boards and on the damp earthen floor of a cellar showed no great difference in the results as regards the number of chickens hatched. Experiments in keeping fertilized and unfertilized eggs at temperatures varying from 46 to 84° F. indicated

that eggs of either kind would preserve a good condition and flavor for several weeks, even at the highest temperature tried. During two winters the effects have been observed of feeding warm mixtures of ground meal of various kinds, with or without the addition of ground meat and red pepper, to stimulate laying. The results indicate that—

(1) The stimulating and fattening foods which go to eggs in the Spanish family, such as Leghorns, Minorcas, and Andalusians, make the Asiatics, viz, Brahmas, Cochins, and Langshans, so fat as to lay soft-shell eggs or not to lay any at all.

(2) Plymouth Rocks and Wyandottes (breeds of American origin, and not to be properly classed with either of the foregoing) are to be treated as Asiatics in the matter of food.

(3) It is best when possible to keep the pullets of late hatch away from the two-year-old hens, for the reason that the latter are at their best for egg production, and the fattening food that is suitable for pullets is likely to make the hens too fat to lay. The importance of having pullets hatched as early as possible will thus be apparent.

The author recommends that young chickens should be fed bread soaked in milk and squeezed dry. At first this should be given every hour, but the number of daily rations should be decreased as the chickens grow older, and after 2 weeks wheat may be fed, sparingly at first.

Report of the Superintendent of Experimental Farm for the Maritime Provinces, W. M. Blair (pp. 230–238).—Tabulated data are given for tests of 21 varieties of wheat, 17 of oats, 13 of barley, 30 of corn, and 69 of potatoes.

Report of Superintendent of Experimental Farm for Manitoba, S. A. Bedford (pp. 239–269).—Tabulated data are given for tests of 32 varieties of wheat sown on upland prairie and 33 sown in a valley, 20 of oats on the upland and in a valley, 11 of barley on the upland and 11 in the valley, 7 of peas, 16 of turnips, 5 of carrots, 83 of potatoes, 32 of fodder corn, and 4 of millet. There are also brief accounts of experiments in sowing wheat and barley at different dates, and wheat, barley, and oats at different distances and in drills and broadcast. Tabulated notes are given for the varieties of apples, crab apples, cherries, pears, plums, gooseberries, currants, and the species of forest trees and shrubs planted at the farm. Experiments are being made in the keeping of bees.

Report of Superintendent of Experimental Farm for the Northwest Territories, A. Mackay (pp. 270–292).—Tabulated data are given for tests of 48 varieties of wheat, 32 of barley, 16 of oats, 5 of peas, and 25 of fodder corn. There are also notes on experiments with forage plants, grasses, flax, buckwheat, beans, turnips, mangel-wurzels, carrots, sugar beets, potatoes, and a number of other vegetables; with apples, crab apples, pears, plums, cherries, currants, raspberries, gooseberries, and strawberries; and with forest trees and shrubs. Brief statements are made regarding the pedigrees of the cattle in the station herd. Experiments with poultry and with bees are in progress.

Report of Superintendent of Experimental Farm for British Columbia, T. A. Sharpe (pp. 293–309).—This includes lists of varieties of apples, peaches, pears, quinces, apricots, nectarines, plums, cherries, figs, oranges, grapes, blackberries, currants, gooseberries, and strawberries under experiment; tabulated data for tests of 12 varieties of winter wheat, 14 of spring wheat, 2 of winter rye, 19 of barley, 13 of oats, 29 of corn, 20 of beans, and 31 of potatoes; and lists of the species of forest trees, shrubs, and vines planted at the farm. The number of eggs laid by each of several breeds of hens during 1890 is given in a table.

EXPERIMENT STATION NOTES.

ARIZONA STATION.—V. E. Stolbrand, C. E., has been appointed meteorologist and irrigation engineer, and E. L. Benton horticulturist.

COLORADO COLLEGE AND STATION.—W. J. Quick, B. S., formerly agriculturist of the station, has been appointed director.

NEW YORK STATE STATION.—S. A. Beach, B. S. A., has entered upon his duties as horticulturist to the station.

OKLAHOMA STATION.—A. C. Magruder, formerly of the West Virginia Station, has been elected agriculturist and horticulturist. The station farm has been surveyed and the erection of buildings will be begun without delay.

PENNSYLVANIA STATION.—The barn on the college farm was completely destroyed by fire November 4.

VERMONT COLLEGE AND STATION.—The facilities for instruction in agriculture and the mechanic arts have been increased. A new building has been erected for the mechanical and engineering departments, and thoroughly equipped with apparatus for instruction in mechanical, electrical, civil, and sanitary engineering. A dairy school, opening December 1, will be held for 4 weeks.

The station has purchased a new farm near its laboratory building, and has erected a dwelling house, barn, creamery, and greenhouse. The station is now well equiped for experiments in botany and dairying. Purchases of registered stock of the Jersey, Ayrshire, and Holstein breeds have been made.

WASHINGTON STATION.—It is expected that the working staff of this station will be organized so as to commence experimental work during the coming season.

BRAZIL.—The report for 1890 of the station at Campinas, of which A. B. U. Cavalcanti is director, has been received. It includes analyses of soils from the State of Sao Paulo, analyses of coffee and an article on the culture of coffee in Brazil, by F. W. Dafert, Ph. D., notes on alfalfa and other forage plants, with analyses of meteoric water, and record of meteorological observations.

HALLE, GERMANY.—*Versuchs-Station für Nematodenvertilgung* desires to be put on the mailing list of the stations, and especially to receive all publications on entomology and mycology. Its annual report will be sent in exchange. Address Dr. M. Hollrung, Wurchererstrasse 1, Halle, Germany.

WORLD'S COLUMBIAN EXPOSITION.—A committee appointed to prepare rules to govern the conduct of a test of dairy breeds of cattle, in connection with the Columbian Dairy School, has submitted its report. Two tests of breeds are provided for. One of these is to continue 4 months, "1 month of which shall be devoted to cheese making, and shall be carried on in connection with the Columbian Dairy School; the other shall be for 7 days, 30 days, and 60 days, and be under the charge of the same committee as the 4 months' test, but the milk may be handled by the breeders." In the 4 months' test two classes of awards are to be made, (1) "for the best dairy cows, considering all commercial products and the value of increase of flesh; (2) for cows, herds, and breeds on the basis of the amount of butter or cheese made during the 4 months." It is recommended that the testing committee consist of the superintendent of the dairy department as chairman, one member appointed by the World's Columbian Exposition, one by the Columbian Dairy Association, four by the Association of American Agricultural Colleges and Experiment Stations, and a representative for each of the breeds competing.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING NOVEMBER, 1891.

Preliminary Report of the Secretary of Agriculture, 1891.

DIVISION OF STATISTICS:

Report No. 90 (new series), November, 1891.—Report on Yield of Crops per Acre; Freight Rates of Transportation Companies.

DIVISION OF BOTANY:

Bulletin No. 14.—Ilex Cassine, the Aboriginal North American Tea

ENTOMOLOGICAL DIVISION:

Insect Life, vol. IV, Nos. 3 and 4, November, 1891.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Record, vol. III, No. 3, October, 1891.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING NOVEMBER, 1891.

CANEBRAKE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 12, October, 1891.—Grapes, Strawberries, and Raspberries.

ARKANSAS AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 16, July, 1891.—Ringworm.

COLORADO AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 16, July, 1891.—Artesian Wells of Colorado.

AGRICULTURAL EXPERIMENT STATION OF FLORIDA:

Bulletin No. 14, July 1, 1891.—Annual Report.

KANSAS AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 24, September, 1891.—Enzoötic Cerebritis or Staggers of Horses.

LOUISIANA AGRICULTURAL EXPERIMENT STATIONS:

Bulletin No. 11 (second series).—Report of the Sugarhouse and Laboratory for 1890.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:

Meteorological Bulletin No. 34, October, 1891.

EXPERIMENT STATION OF MICHIGAN AGRICULTURAL COLLEGE:

Bulletin No. 77, November, 1891.—Comparing the Yield of Old Meadows with those Recently Seeded.

MISSISSIPPI AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 16, September, 1891—Glanders.

NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS:

Bulletin No. 84, October 10, 1891.—Ground Bone and Miscellaneous Samples.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 32, October, 1891.—Tomatoes.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 80*b*, September 15, 1891.—Meteorological Summary for North Carolina, August, 1891.

Bulletin No. 80*d*, October 15, 1891.—Meteorological Summary for North Carolina, September, 1891.

OHIO AGRICULTURAL EXPERIMENT STATION:

Bulletin vol. IV, No. 6 (second series), October, 1891.—Experiments with Small Fruits in 1891; Diseases of the Raspberry and Blackberry.

OREGON EXPERIMENT STATION:

Bulletin No. 12.—Comparative Test of Strawberries for 1891; Meteorological Summary.

Bulletin No. 13.—Mineral and Mineral Water Analyses; Soils and Agricultural Survey.

THE PENNSYLVANIA STATE AGRICULTURAL COLLEGE EXPERIMENT STATION:

Bulletin No. 17, October, 1891.—The Value of Cotton-Seed Meal as Compared with Bran for the Production of Butter.

RHODE ISLAND STATE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 12, August, 1891.—Analyses of Commercial Fertilizers Collected under the State Inspection, 1891.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 2 (new series), July, 1891.—Cotton Experiments with Varieties and with Fertilizers.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF WISCONSIN:

Bulletin No. 29, October, 1891.—Creaming Experiments.

DOMINION OF CANADA.

ONTARIO AGRICULTURAL COLLEGE EXPERIMENT STATION:

Bulletin No. 68, October 26, 1891.—Feeding Shorn and Unshorn Lambs in Winter.

Bulletin No. 69, November 2, 1891.—Fattening Lambs for the British Market.

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U. S. DEPARTMENT OF AGRICULTURE

OFFICE OF EXPERIMENT STATIONS

A. W. HARRIS, DIRECTOR

EXPERIMENT STATION

RECORD

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EXPERIMENT STATION RECORD.

Vol. III. ISSUED JANUARY, 1892. No. 6.

EDITORIAL NOTES.

A general survey of the work reported by investigators in the science and practice of agriculture in 1891 gives abundant reason for encouragement. In our own country the experiment stations have become more firmly established and are increasing the regularity and thoroughness of their operations. In foreign lands researches in agriculture are engaging the attention of an increasing number of scientists. New stations have been established. Improved methods of experimenting have been devised. No previous year has witnessed so general an awakening of farmers to the need of better education in the theory and practice of their art. Everywhere the idea that scientific principles can be successfully applied to the betterment of the industries of life is rapidly spreading among the masses. Governments reflect the growing influence of public opinion in this direction by a larger interest in institutions by which the aid of science may be directly brought to bear on the welfare of the people. A notable instance of this in our own country is presented in the transfer of the Weather Bureau to the Department of Agriculture, with a distinct purpose to enlarge its usefulness to farmers and to enable it to give more attention to the relations of meteorology to the growth of agricultural products. A few illustrations of the lines in which investigation has rendered notable service to agriculture during the past year may serve to enforce these general statements.

In the interests of the diversification of agriculture, so urgently demanded in many of the States west of the Mississippi River, a number of the stations, as well as this Department, have conducted experiments to test the adaptability of their respective localities to the production of sugar beets. Reports on this subject have been received during the year from stations in Iowa, Colorado, Nebraska, South Dakota, Minnesota, Wisconsin, Nevada, Arkansas, and Wyoming. These experiments indicate that beets with high sugar content may be raised in many parts of the region covered by these States. In the arid region particularly

it is found that the beets grown with irrigation, by which the moisture in the soil is subject to the control of the farmer, are especially rich in sugar. Already sugar factories have been established in Nebraska, California, and Utah, and it is estimated that about 13,000 tons of beet sugar were made in this country during the past year.

In a similar way the experiments in the use of alcohol in the making of sorghum sugar, conducted by this Department, have been highly successful. It is believed that this process will double the amount of crystallized sugar to be obtained from a given quantity of cane at a trifling increase in cost. Experiments on a factory scale have already shown such results. This process gives an unusually pure product, the sugar being fit for many purposes without refining.

The past year's work in testing the devices contrived by the stations for rapidly determining the amount of fat in milk, has made it reasonably sure that dairymen and creameries have at their disposal a practical method which will enable them to fix the value of each cow's milk according to its quality. The farmer no longer has any excuse for keeping unprofitable stock and the creameries have no valid reason for refusing to pay for milk on the basis of its quality.

Among more strictly scientific investigations in agricultural lines none have attracted greater attention during 1891 than those in which the functions of bacteria have been the subject of inquiry. Our knowledge of the pathogenic bacteria has been extended. This Department has published an important report on the causes and prevention of swine plague, in which it is definitely shown that swine plague and hog cholera are distinct diseases, each having an easily recognizable specific germ. Interesting researches have also been made in the application of Koch's lymph to the diagnosis of tuberculosis in domestic animals. But the observations on bacteria which are useful to agriculture have been far more striking in their results than any reported on injurious bacteria.

The question as to the cause of the nitrification of ammonium salts in soils has recently found a definite answer in the investigations of Winogradsky at Zurich. The nitrifying organisms so often searched for seem to have been found, successfully isolated and cultivated, and their characters, nitrifying action, and methods of culture carefully studied.

The most recent investigations of Lawes and Gilbert, Hellriegel, Nobbe, and others not only confirm the results of earlier inquiries which have shown that bacteria are intimately connected with the acquisition of atmospheric nitrogen by leguminous plants through their root tubercles but also indicate that particular species of bacteria perform this service for the several kinds of plants. Some experiments even indicate that bacteria may be turned to practical account in the production of leguminous crops. For example, it has been found on a small scale that the sprinkling of soil containing lupine bacteria over other soil in which lupines had been planted, promoted the growth of these plants.

In the dairy the relations of bacteria to the souring and creaming of milk have been more clearly defined, and it has been shown that the flavor of butter depends in large measure on the control of bacteria during the processes of butter making.

Studies of the bacteria which cause the fermentation of tobacco during the process known as bulking, have indicated that the kinds of bacteria vary in different varieties of tobacco. When pure cultures of the bacteria peculiar to any sort of tobacco were used for inoculating tobacco of another sort, it was found that they induced the same taste and aroma observed in the tobacco from which they were derived. This suggests that tobacco of poorer quality may be improved by inoculating with bacteria peculiar to the choicer sorts.

Feeding experiments with dairy cows at several of our stations have brought out interesting data regarding the influence of different rations on the quality of butter. The results of a very thorough series of experiments by Fleischmann, an account of which may be found on page 424 of the present number of the Record, indicate that both the absolute and relative amount of fat in milk can be changed by varying the rations of cows.

In horticulture a series of experiments at the New York Cornell Station have shown striking effects on plant growth from the use of the electric light in greenhouses, and have considerably extended our information on this interesting subject. Already it is reported that some of these results have been confirmed by independent experiments by a market gardener in Massachusetts. Experiments at the Massachusetts Hatch Station indicated that an electric current transmitted on wires laid in the soil near the roots of lettuce, promoted the vigorous growth of the plants. It now seems probable that electricity will at no distant day help to supply our tables with green vegetables throughout the winter.

This Office has recently issued the first installments of a general index of the literature of agricultural experiment stations and kindred institutions. In view of the mass and variety of this literature, the desirability of a general index has impressed itself upon this Office from the time of its organization. The need of such an index has also been deeply felt by the station workers and has often been expressed in their meetings and through correspondence with this Office. The importance of the work made it all the more necessary that the plans for its accomplishment should be carefully matured. This and various other considerations have made it impracticable to begin the issuing of the index until the present time.

Much study has been devoted not only to the general plan and arrangement of the subject matter of the index, but also to the typographical and other details. The advice and assistance of station

workers and of individuals who have had experience in the making of indexes has been sought. Especial acknowledgment is made to Dr. Goodell of Massachusetts and Dr. Frear of Pennsylvania, who acted as a committee of the Association of American Agricultural Colleges and Experiment Stations to aid this Office in defining its plans for the index. Many opinions regarding the arrangement of the index have been brought out, and it is not expected that in its present form it will meet all the varied requirements of individual workers. It is expected, however, that experience will show that the plan adopted will meet the needs of students of agricultural science as far as could reasonably be hoped.

The index of current American station literature begins with the year 1890. Work has also been begun on the past American literature and will proceed from 1890 back to the beginning of investigations in agricultural science in this country. As soon as practicable foreign literature will be taken up.

The general plan on which the index will be constructed may be briefly outlined as follows: The subjects with which agricultural science deals have been grouped under a limited number of general topics. These topics have been divided and subdivided only so far as seemed necessary to facilitate references to the individual entries of the index. The classification adopted is as follows:

(1) *General sciences.*—Physics, chemistry, mineralogy, geology, botany, bacteriology, animal physiology, zoölogy, meteorology.

(2) *Air and water.*

(3) *Soil.*—History and classification, physics, chemistry, tillage, methods of investigation.

(4) *Fertilizers.*—History, nature, and uses, farm manures, commercial fertilizers, experiments, inspection.

(5) *Plants.*—Field crops (history and uses, species and varieties, composition, culture, manuring, curing and storage, and rotation), horticulture (vegetables, orchard fruits, small fruits, grapes, nuts, landscape gardening, and floriculture), forestry, seeds, weeds, diseases of plants (parasitic, non-parasitic, remedies).

(6) *Foods (for domestic animals and man).*—Composition and valuation, nutritive values, preparation and use, food accessories, beverages, adulteration.

(7) *Animals.*—History and general principles, breeds and breeding, animal production (cattle raising, dairy farming, sheep husbandry, swine husbandry, horse and mule husbandry, aviculture), veterinary science and practice.

(8) *Economic entomology.*—Beneficial insects (apiculture and sericulture), injurious insects (affecting animals, affecting plants, insecticides, insecticide appliances).

(9) *Dairying.*—History and general principles, composition and properties of milk and its products, changes in milk (fermentative changes due to bacteria, etc., and creaming), handling of milk, inspection, butter making and creameries, cheese making and factories.

(10) *Technology.*—Milling, starch, sugars, fermented liquors, fats and oils, textiles.

(11) *Agricultural engineering.*—Properties of materials, drainage, irrigation, farm implements, roads and bridges, fences, farm buildings.

(12) *Station statistics.*—History and organization, legislation, equipment, (apparatus, buildings, farms, implements, live stock), finances, bibliography.

(13) *Miscellaneous.*—Rural economy, agricultural education, agricultural statistics.

In this scheme the logical division of subjects has been sacrificed as far as seemed necessary to increase the practical usefulness of the index. The arrangement is such that new divisions and subdivisions may be introduced without interfering with those previously made.

One of the greatest difficulties in the classification of the subjects treated in agricultural science arises from their mixed nature, due not only to their economic relations, but also to their involving matters which in a strictly scientific classification would belong under two or more separate heads. This difficulty is increased by the practical necessity of keeping the index within reasonable limitations as regards size. As far as possible the duplication of entries by cross-references is to be avoided in an index of this magnitude. As the work of the stations reaches out in many directions into the domain of pure as distinguished from applied science, it was deemed desirable to set apart a portion of the index for entries relating to the general principles of the various sciences which lie at the foundation of experimental investigations in agriculture. A further reason for this arrangement is that there will thus be a place in the index where any works on science which are found to be useful to students in agricultural lines can be referred to. This will afford the widest opportunity for the extension of the index by individual students for their own special purposes. It should be clearly recognized that any attempted classification of such varied and complex subjects will be more or less unsatisfactory to the individual student. Experience will doubtless show in what direction the classification adopted can be extended or improved.

The index is printed on cards. This system has been adopted because experience seems to show that it affords the greatest opportunity for diversification of arrangement and for the indefinite extension of an index under a single classification. The cards are of the standard library size, individuals who have had most experience in the preparation and use of card indexes being almost unanimous in advocating this size of card. The divisions and subdivisions have been arranged on a decimal system, and are plainly indicated by the use of division cards of different colors.

Each index card will contain the title of an article, the name of its author, a reference to the publication in which it appeared and to the Experiment Station Record, and a condensed statement of its contents. At the upper right-hand corner of the card is a number indicating under what head the card should be placed in the index. The order in which the cards are printed is indicated at the lower left hand corner.

A key to the index, containing the system of classification, was sent out with the first installment of cards.

One copy of the index will be sent to each of the agricultural colleges and experiment stations in the United States, where it will doubtless be accessible to students of agricultural science who may desire to consult it.

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Alabama Canebrake Station, Bulletin No. 12, October, 1891 (pp. 10).

GRAPES, STRAWBERRIES, AND RASPBERRIES.—*Grapes.*—The station vineyard planted in 1889 and the methods of cultivation employed therein are described in a passage quoted from Bulletin No. 6 of the station (see Experiment Station Record, vol. I, p. 188). Tabulated data are given for 31 varieties of grapes, including "a description of the grapes, time of ripening, color, size of berry, condition in and out of sacks, quality, size and shape of bunch, growth of vine, and prolificness." The experiments thus far indicate that grapes can be successfully grown on the "red prairie" lands.

The effect of sacking was very marked on the different varieties. All of the black varieties were perfect in sacks, except Telegraph and Black Eagle. The Telegraph and Black Eagle kept much better out of the sacks, the Black Eagle being perfect.

All of the white grapes rotted more or less in the sacks and it does not pay to sack any varieties of them except Niagara, Beauty, and Maxatawney. It is not best to put too many of them in the sacks. Delaware and Wyoming Red all rotted in the sacks, while the other varieties of red grapes did well. Vergennes and Agawam kept better than the other red varieties.

Perkins, Ives, and Norton Virginia kept best, and can be kept in sacks from 10 to 30 days after ripening.

The best black varieties for the prairie are Concord, Ives, Champion, Worden, Merrimac, Rogers No. 11, Wilder, and Norton Virginia. * * *

Of the white grapes, Niagara, Gœthe, Beauty, and Prentiss do well.

Delaware, Lindley, Vergennes, Agawam, and Wyoming Red are the best of the red varieties.

Perkins is one of the best varieties that can be grown. The vines are healthy, very vigorous, and prolific. They ripened as early as any of the varieties and a much better price was obtained for them. It is best not to let them ripen thoroughly. Then they are of a deep brown color and have a very decided foxy taste.

Strawberries.—In December, 1888, 25 varieties were planted on "shelly land." Only a few of these varieties have proved in any way adapted to the canebrake lands, and even these can not be profitably grown on a large scale. For home use, Sharpless, Wilson, Albany, Champion of Kentucky, and No. 1001 are the most promising varieties.

Raspberries.—The varieties planted at the station on "shelly land" have proved failures.

Arkansas Station, Bulletin No. 16, July, 1891 (pp. 15).

RINGWORM, R. R. DINWIDDIE, M. D., V. S. (figs. 2).—A popular account of the nature, symptoms, cause, and treatment of a skin disease of young cattle caused by the fungus *Trichophyton tonsurans* and commonly known as ringworm or "white scab."

California Station, Bulletin No. 94, September 23, 1891 (pp. 8).

COMPOSITION OF THE RAMIE PLANT, M. E. JAFFA, PH. B. (pp. 1–6).—"The object of the present investigation is to show the actual amounts of mineral ingredients withdrawn from the soil by the different parts of the [ramie] plant, and to point out the great necessity of returning to the soil the leaves and stalks after decortication." Reference is made to experiments at Padua, Italy, by M. Goncet de Mas, and at the University of California on a much smaller scale, which "have proved that on good soils where from three to four cuts can be made annually, the yield will be about 10 tons of dried stalks per acre. M. Goncet de Mas, in the third year after planting, obtained from two cuts nearly 9 tons of dried stalks. We are told by Mr. McAfee of Bakersfield that the best fiber is produced when three instead of four cuts are made annually." Separate analyses were made of the whole plant, stalks (without bark), bark (including fiber and gum), and leaves. The results are given in the following table:

Composition of ramie plant.

	Whole plant.	Stalk.*	Bark.†	Leaves.
In fresh plant:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Water	81.26	81.75	80.91	80.65
Ash	1.49	0.57	0.31	3.81
Nitrogen	0.258	0.146	0.210	0.481
In 100 parts of ash:				
Potassium oxide	11.82	37.79	32.58	4.18
Sodium oxide	2.35	8.15	8.77	0.54
Calcium oxide	30.87	17.32	22.28	34.74
Magnesium oxide	7.89	10.58	11.64	7.02
Ferric oxide and alumina	2.41	2.95	0.84	2.35
Monoxide manganese	0.17	0.35	0.18	0.12
Phosphoric acid	7.29	16.38	12.64	4.72
Sulphuric acid	2.26	3.46	3.68	1.88
Silica	33.01	1.56	5.24	42.42
Chlorine	2.43	1.87	2.75	2.55
	100.50	100.41	100.60	100.52
Less excess of oxygen due to chlorine	0.50	0.41	0.60	0.60
Total	100.00	100.00	100.00	99.92

* Stalk without bark. † Including fiber and gum.

It is found that 5 tons of wet or fresh stalks are equivalent to 1 of dry.

We find that the leaves constitute about 30 per cent of the dried plant, the decorticated stalk 51 per cent, and the bark 19 per cent. Of the latter, nearly 15 per cent is raw fiber, containing 30 per cent of gum, thus making the percentage of pure fiber in the plant as grown here about 11. * * * The proportion of pure fiber referred to stalk alone [without leaves] is about 15 per cent.

The amount of valuable fertilizing ingredients contained in four cuttings of ramie (per year), yielding 10 tons of dried stalks and 4.25 tons of leaves per acre, is calculated from the above data to be as follows:

Fertilizing ingredients per acre in ramie crop.

	Potash.	Phosphoric acid.	Nitrogen.
	Pounds.	*Pounds.*	*Pounds.*
Whole plant (14.25 tons)	251.98	155.70	369.70
Stalks (7.25 tons)	155.99	67.71	105.85
Bark (2.75 tons)	27.86	10.86	57.75
Leaves (4.25 tons)	68.13	77.13	206.10

"A consideration of the data given in the table proves to what an alarming extent the soil would be depleted by a continuous culture of ramie when nothing is returned. * * * The draft made on lime is about 658 pounds, on potash 252 pounds, phosphoric acid 156, and on nitrogen to the extent of 370 pounds per acre."

Of these amounts, however, there is contained in the bark and fiber, the only products aimed at, less than 10 per cent of the potash, 3 per cent of the lime, 7 per cent of the phosphoric acid, and 15 per cent of the nitrogen, the remainder being contained in the stalks and leaves.

If the leaves and stalks are returned to the soil, the amount withdrawn is, comparatively speaking, very small, being only about 28 pounds of potash, 19 of lime, 11 of phosphoric acid, and 58 of nitrogen per acre. * * * When the decorticated stalks only are returned to the soil, as might be the case if the leaves were sold to paper mills, as has been suggested, then about 68 pounds more of potash, 567 of lime, 77 of phosphoric acid, and 206 pounds of nitrogen per acre are taken away from the soil than would be the case were they, with the stalks, given back to the land.

Whether or not it would pay to sell the leaves is a financial question depending on the prices obtained for them, and upon that which would have to be paid, sooner or later, for fertilizers used instead.

Remarks on the manner of using the stalks and leaves for fertilizing purposes are reprinted from Bulletin No. 90 of the station (see Experiment Station Record, vol. II, p. 475). A comparison is given between the amounts of mineral ingredients and nitrogen contained in a crop (total and parts of plant) of ramie per acre, and in crops (total and parts of plant) of hemp, flax, cotton, wheat, and sugar beets, calculated from various analyses, and crops of grapes, oranges, pears, plums, and apples. The amounts of nitrogen, phosphoric acid, and potash per acre in fiber plants and in wheat and sugar beets (total crop) are given as follows:

Fertilizing ingredients per acre in various crops.

Crop.	Nitrogen.	Phosphoric acid.	Potash.
	Pounds.	*Pounds.*	*Pounds.*
Ramie (yielding 10 tons of dried stalks)	369.7	155.8	252.0
Hemp (yielding 1,000 pounds of clean fiber)	62.7	33.2	101.3
Flax (yielding 600 pounds of fiber)	74.5*	40.6	43.8
Cotton (yielding 400 pounds of lint)	23.2†	22.5	35.3
Wheat (yielding 20 bushels of grain)	42.0	19.8	43.9
Sugar beets (yielding 40,000 pounds of roots)	173.4	116.2	387.4

* In straw and seed. † In seed.

Of all the fiber plants, ramie stands first as regards depletion of the soil of plant food—a result which was to be expected from the greater mass of the plant harvested, since from three to four cuts can be made of the ramie, while only one each of hemp and flax is made. Taking average crops, hemp is second in total amount of ingredients removed, cotton third, and flax fourth. * * * On the whole, ramie culture, when all "offal" is returned, is fairly comparable to the less exhaustive fruit crops; but without such return it must be classed among the most exhaustive cultures known.

THE FERTILIZING VALUE OF GREASE WOOD, E. W. HILGARD, PH. D. (pp. 7, 8).—An analysis is given of the ash of grease wood (*Sarcobatus vermiculatus*), and a comparison of this with the ash of samphire, seaweed, cabbage, and timothy hay. The grease wood contained 12.03 per cent of ash. The composition of this was as follows:

	Per cent.
Potassium oxide	18.53
Sodium oxide	39.45
Calcium oxide	1.36
Magnesium oxide	1.09
Peroxide of iron and alumina	7.06
Phosphoric acid	3.51
Sulphuric acid	4.93
Chlorine	15.30
Silica	11.81
	103.04
Less excess of oxygen due to chlorine	3.25
	99.79

Nearly 40 per cent of the ash is soda, out of which over 25 per cent of common salt and nearly 8 per cent of Glauber's salt are formed. There remains out of the total amount shown in the analysis 23 per cent that will go toward forming carbonate of soda, increasing its weight to about 39 if returned to the soil. This means that out of 100 pounds of grease-wood ash 72 pounds would be "alkali" of the usual composition of "black alkali," which would at the very least be of no use to any soil.

Colorado Station, Bulletin No. 16, July, 1891 (pp. 28).

THE ARTESIAN WELLS OF COLORADO, L. G. CARPENTER, M. S. (plates 3).—This includes a popular résumé of information regarding the location and cost of artesian wells, with special reference to their use for irrigation; a brief history of the artesian wells of Colorado; a

brief summary of an account of the wells of the Denver Basin, published in the Progress Report of the Office of Irrigation Inquiry of this Department (see Experiment Station Record, vol. III, p. 328); and statements concerning the wells in the San Luis Basin, largely derived from recent investigations by the author. The San Luis Valley has a mean elevation of over 7,500 feet, and is surrounded by the highest mountains in the State. The rainfall is scanty, but with the aid of irrigation from the Rio Grande River large crops, especially of cereals and potatoes, are grown. The first well was dug in 1887, but there are now probably as many as 2,000. Many of these wells are shallow and inexpensive, but at Alamosa one well obtains its flow from a depth of 932 feet. The temperature of the water, as determined for nearly 100 wells in different parts of the valley, varies from 46.2° F. at 85 feet to 74.7° at 932 feet. The pressure varies from 12 to 56 feet. The wells are situated in the basin of an ancient lake. Most of the wells have been sunk for domestic purposes, though where the flow is large they are used to some extent for irrigation.

Connecticut Storrs Station, Third Annual Report, 1890 (pp. 200).

REPORT OF EXECUTIVE COMMITTEE (pp. 5–7).—Brief general statements regarding the personnel and operations of the station.

REPORT OF TREASURER, H. C. MILES (pp. 7, 8).—A statement of receipts and expenditures for the fiscal year ending June 30, 1890.

REPORT OF DIRECTOR, W. O. ATWATER, PH. D. (pp. 9–11).—A brief review of the lines of investigation followed at the station during the year.

ACQUISITION OF ATMOSPHERIC NITROGEN BY PLANTS, W. O. ATWATER, PH. D., AND C. D. WOODS, B. S. (pp. 12–14).—A short report is given of studies on the acquisition of atmospheric nitrogen by scarlet clover, incarnate clover, Japan clover, alfalfa, yellow lupine, soja beans, red eyed beans, millet, and buckwheat. The plants were grown in sea sand, all being "supplied with the necessary amount of plant food, with the exception of nitrogen, and to some of the plants nitrogen was supplied in the form of calcium and potassium nitrates. Rather more than half of the plants were inoculated with infusions prepared by treating soil taken from near the roots of growing plants of the same or allied species." The alfalfa "made only a small growth during the summer, and the roots are being wintered over" with a view to continuing the experiment another season.

On the whole the season's results were negative rather than positive. A few bean plants, with a fair number of root tubercles, gave a gain of several milligrams of nitrogen. For the most part the nitrogen-fed plants showed a very large loss of nitrogen, probably owing to decomposition of the nitrates fed.

It is not thought that the negative results obtained with these different species of legumes indicate that the plants may not, under favorable circumstances, acquire atmospheric nitrogen; but they seem to us to imply that, while we have learned

how to grow pea plants with reasonable success in each experiment, we have not as yet learned how to grow all species of plants in such a way as to insure normal development.

Mention is made of a series of experiments on this subject already planned, in which it is proposed to grow the plants in an atmosphere freed from nitrogen compounds.

A greenhouse has been erected; a power air pump for forcing a current of air and apparatus for washing the air so as to free it completely from all nitrogen compounds, have been procured; an air-tight case large enough to hold 30 pea plants in separate pots or jars has been constructed, and preliminary experiments are now in operation. If the winter's experience is successful, we hope to undertake the experiments proper during the coming spring and summer.

ANALYSES OF FEEDING STUFFS, C. D. WOODS, B. S. (pp. 14–25).—Analyses with reference to food ingredients of Champion of England and East Hartford early peas, Six-Weeks' beans, soja beans (vines and seeds), horse beans, cowpea vines, vetch (vines and seeds), vetch and oats, red clover, white, yellow, and blue lupine, fodder wheat, oats and peas, tall meadow fescue, fodder corn, corn (kernels), and buckwheat middlings. The analyses of the 2 varieties of peas and the beans follow:

Analyses of peas and beans.

Variety.	Water.	In 100 parts of dry matter.				
		Crude cellulose.	Crude fat.	Crude protein.	Nitrogen-free extract.	Crude ash.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Champion of England peas	12.07	5.13	2.07	31.88	57.32	3.60
East Hartford early peas	13.74	3.09	1.28	29.06	63.12	3.45
Six-Weeks' beans	11.46	3.68	2.04	22.50	68.05	3.73

PROXIMATE COMPOSITION OF GOOD AND OF POOR CORN, C. D. WOODS, B. S. (pp. 26–28).—By good corn is meant the merchantable ears, and by poor the soft ears and nubbins.

In 1889 samples of good and of poor corn were taken from five and in 1890 from four field experiments. The variety grown was flint corn, and in 1889 the seed was all from one source. * * *

[The results of analyses of these samples are tabulated.]

The percentage of protein in poor corn exceeds that in good by an average of 1.5 per cent, varying from a minimum of 0.75 per cent in Mr. Healey's experiment to 2.3 per cent in Mr. Dean's. There is very little difference in the amount of crude fiber in the two grades of corn. The percentage of ash is 0.2 per cent greater in poor than in good corn.

There is an average of 0.4 per cent more fat or oil in the good than in the poor corn. The percentage of nitrogen-free extract in the good corn is increased by an average of about 1.4 per cent.

FERTILIZING INGREDIENTS IN CROP AND IN ROOTS OF LEGUMES, C. D. WOODS, B. S. (pp. 29–36).—This includes analyses with reference to fertilizing ingredients of several samples of cowpea vines, soja beans (beans and vine), horse beans, vetch vines, clover, and white, blue, and yellow lupines; a calculation of the amount of these

ingredients in crops of these plants per acre; analyses of duplicate samples of the stubble and roots of cowpeas and of soja beans; a statement of the fertilizing ingredients contained in the roots and stubble from crops of cowpeas, soja beans, horse beans, vetches, clover, and white, blue, and yellow lupines, and a summary of these data, showing amount per acre of nitrogen, phosphoric acid, and potash removed with these crops from 1 acre, the amount left behind in roots and stubble, and the total amount found in crop, stubble, and roots. For the purpose of comparison the amounts of ingredients furnished by different fertilizers are given. Remarks are made on the value of leguminous plants for green manuring.

FODDER CROPS FOR SOILING AND FOR SILAGE, C. S. PHELPS, B. S. (pp. 37–43).—Notes on the growing of fodder wheat, silage corn, barley and pea fodder, vetch and oats, oats and peas, soja beans, and cowpeas, for feeding purposes, together with reports from farmers who have tried them.

SPECIAL NITROGEN EXPERIMENT ON GRASS, C. S. PHELPS, B. S., AND C. D. WOODS, B. S. (pp. 44–56).—The object of this experiment was to observe the effects of different nitrogenous fertilizers furnishing the same amounts of nitrogen on the yield of grass and hay, on the composition of the crop, and on the financial results. The 10 eighth-acre plats were on a medium-heavy loam soil which "was in a low state of fertility." The land had been in grass without fertilizers for several years. The plats were separated by unmanured strips. The grass consisted chiefly of timothy, redtop, and Kentucky blue grass, with a slight admixture of clover. All of the plats except 2 unmanured plats received 320 pounds of dissolved boneblack and 160 pounds of muriate of potash per acre. On 6 plats nitrate of soda or ammonium sulphate were also added, each in amounts furnishing 25, 50, and 75 pounds of nitrogen per acre. The fertilizers were all applied April 29. The grass was cut for hay June 25. The yields of hay per acre, calculated to a water basis of 11 per cent; the financial results, allowing $12 per ton for the hay; the percentage composition of the hay from each plat; and the calculated amount of food ingredients in the crop from each plat are fully tabulated. The indications of the experiment are as follows:

The addition of mineral fertilizers increased the yield of clover, especially white clover, but did not seem to increase in any marked degree the yield of grasses.

The yield of hay increased with the quantity of nitrogen supplied, whether it was applied in the form of nitrate of soda or sulphate of ammonia. This favors the assumption that the grasses responded directly to the nitrogen.

The yields obtained from the nitrate-of-soda plats were about the same in amount as those from the plats to which corresponding amounts of sulphate of ammonia were applied. In the latter the nitrogen cost 2 cents per pound more than in the former, so that the financial returns are in favor of the nitrate of soda.

The mineral fertilizers when used alone were used at a financial loss.

The best financial returns, a gain of $5 per acre, were obtained from the use per acre of 320 pounds of nitrate of soda (50 pounds of nitrogen) in addition to the mixed minerals.

There was a difference of 8 per cent in the water in the field-cured hay [from different plats.] * * * This emphasizes the fact that conclusions far from true may be drawn from field weighings without the additional knowledge of the water content of the crop.

The application of nitrogenous fertilizers increased the percentages of protein in the grasses, and somewhat in proportion to the amounts applied. This is in accord with observations made by the station upon the relation of the protein in maize (corn and stover) to the nitrogen applied in the fertilizers. * * *

The increase in the amount of nitrogen in the crop did not equal the increased amount of nitrogen supplied in the fertilizers, implying that the plants were not able to avail themselves of all the nitrogen supplied.

COÖPERATIVE FIELD EXPERIMENTS WITH FERTILIZERS, C. S. PHELPS, B. S. (pp. 57–92).—These experiments were of three kinds, soil tests, special nitrogen experiments, and special corn experiments. The fertilizers were in all cases supplied by the station, and in most cases the more important details of the experiments were carried out under the supervision of a representative from the station.

Soil tests with fertilizers for corn (pp. 62–71).—These were on four different farms and at the station, each experiment including 10 tenth-acre plats. On these, nitrate of soda 160 pounds, dissolved boneblack 320 pounds, and muriate of potash 160 pounds per acre were used singly, two by two, and all three together; plaster 400 pounds was used on 1 plat and 2 remained unmanured. In the experiment at the station 2 extra plats were added, 1 of which received stable manure 16,000 pounds, and the other stable manure 12,000 pounds, with dissolved boneblack 320 pounds per acre. Other slight deviations from the above plan occurred. The soils represented were mostly loam, ranging from light to clayey. In two cases similar experiments had been made on the same soil the previous year.

The results of the trial on each farm are tabulated, the yields all being calculated to a water content of 11 per cent. The indications were that the soil of one farm needed both potash and nitrogen, and that one especially needed potash, one nitrogen, and one phosphoric acid. The results at the station were not conclusive, the soil proving uneven.

Special nitrogen experiments (pp. 71–74).—Experiments were made on two farms on the same general plan as the one with grass at the station described above, except that dried blood was added, being used in the same manner as the other nitrogenous fertilizers. Potatoes were grown in one case and oats in the other. The tabulated results show no very definite indications in either case, both soils proving rather uneven. "The oats responded quite markedly to nitrogen."

Special corn experiments (pp. 75–92).—"This class of experiments was planned for the purpose of studying the best proportions of phosphoric acid and potash for use in growing corn on soils whose peculiarities had already been studied by means of 'soil tests.' In addition, the profit or loss from the use of the mixtures was also considered."

Four of these experiments were made, the soils being medium-compact loam, a clay loam, and a fine light loam. Each experiment included 10

plats, 2 of which remained unmanured. On the others a nitrogen mixture composed of 75 pounds of nitrate of soda and 100 pounds of dried blood was used with 100 pounds of muriate of potash and 500, 600, or 700 pounds of Thomas slag per acre; with 50 or 150 pounds of muriate of potash and 500 pounds of Thomas slag; or with 100 pounds of muriate of potash and 500 pounds of dissolved boneblack; or 500 pounds of tankage were used with 100 pounds of muriate of potash. The yields of corn and stover and the financial results are tabulated for each experiment. On two farms Thomas slag seemed to give about as good results as an amount of boneblack costing the same: on a third farm boneblack proved the more economical. On one farm "the best results appear to come from the use of large quantities of soluble phosphates, together with 100 or 150 pounds of muriate of potash and about 25 pounds of nitrogen from some readily available source;" on another "large quantities of phosphoric acid and small quantities of potash appear to have given the best financial results;" on a third "the largest yield came from the use of 500 pounds of slag with 150 pounds of potash;" and on the fourth the results were rather inconclusive, but indicated phosphoric acid to be the substance most needed by the soil for this crop.

Effect of different fertilizers upon the composition of oats and straw, C. D. Woods, B. S., and H. B. Gibson, B. A. (pp. 93-106).—Analyses were made of the oats and straw grown in one of the special nitrogen experiments reported above with a view to obtaining additional data on the effects of fertilizers, especially nitrogenous fertilizers, on the percentage of food ingredients in the grain and straw. The soil was a light sandy loam with sandy subsoil. The percentage composition of the grain and straw harvested from each of the 14 plats is given, together with the food ingredients in the same per acre, and the average results obtained are compared with the results of other American analyses of oats. The following table shows the average composition of the dry matter in grain and straw from plats receiving different kinds of fertilizers:

Average composition of oats grown with different fertilizers.

Average of plats receiving—	Grain.					Straw.				
	Crude ash.	Crude cellulose.	Crude fat.	Crude protein.	Nitrogen-free extract.	Crude ash.	Crude cellulose.	Crude fat.	Crude protein.	Nitrogen-free extract.
	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.
No fertilizer	3.29	14.96	5.53	13.66	62.56	4.43	34.82	3.48	8.65	48.62
Mixed minerals	3.01	12.52	5.78	14.31	64.38	4.63	37.23	3.41	6.04	48.69
Nitrate of soda and mixed minerals	2.72	10.45	6.13	16.25	64.45	4.81	38.40	3.57	5.44	47.78
Sulphate of ammonia and mixed minerals	2.83	12.56	6.02	14.69	63.91	4.26	36.89	3.39	6.67	48.79
Dried blood and mixed minerals	2.75	11.92	5.94	14.42	64.99	4.45	38.17	3.18	5.42	48.78

It would seem from these averages that where nitrogenous fertilizers were applied the grain contained a larger percentage of fat and protein

than when no fertilizers or only mixed minerals were used, the increase being most noticeable with nitrate of soda and least so with dried blood. In the straw no perceptible increase followed the application of nitrogenous fertilizers, unless possibly in the case of crude cellulose where nitrate of soda was used.

There was an increase in pounds of protein per acre in the plats supplied with nitrogenous fertilizers somewhat in proportion to the amounts applied. This increase was greatest in the plats to which nitrate of soda was applied. These results are in accord with observations made by the station upon the relation of the protein in maize and in grass to the nitrogen applied in the fertilizer.

The increase in the amount of nitrogen in the crop did not equal the increase in amount of nitrogen applied in the fertilizers, implying that the plants were not able to avail themselves of all the nitrogen supplied.

EFFECTS OF DIFFERENT FERTILIZERS UPON THE COMPOSITION OF CORN, C. D. WOODS, B. S., AND H. B. GIBSON, B. A. (pp. 107-111).—These studies are in continuation of those reported in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 398), and include analyses of the corn and stover raised on the differently fertilized plats in two of the soil tests reported above. No inferences are drawn from the tabulated results.

PROXIMATE COMPOSITION OF CORN AND STOVER OF NEW ENGLAND-GROWN MAIZE, C. D. WOODS, B. S., AND H. B. GIBSON, B. A. (pp. 112-119).—In connection with the studies at the station of the effects of fertilizers on the composition of the corn crop, analyses have been made during the past 3 years of 121 samples of kernels and 101 samples of stover of yellow flint corn, and of 1 sample each of kernels and stover of white flint corn. The maximum, minimum, and average percentages of food ingredients found by these analyses in the corn and stover grown with different fertilizers, are tabulated, and from these the average composition of the corn and stover analyzed is calculated. It was noticed that in general—

The addition of nitrogen produced a corn richer in protein than was obtained from the use of mineral fertilizers alone. * * * The variations in protein of 5, in fat of 3, and in nitrogen-free extract of 6 per cent show that the water-free substance of corn kernels grown upon different soils, with different fertilizers, in different seasons varies greatly in composition and in feeding value. * * *

The variations in percentages of water at harvest and in the composition of the water-free substance of stover are much more marked than those of corn. There is an extreme variation of more than 50 per cent in the water at harvest and of 7 per cent in the protein. In some cases the percentage of protein in stover equals that of average corn and exceeds that of some of the corn by nearly 2 per cent. The great range indicates the great differences that may be expected in the feeding values of stover from different fields or even from different parts of the same field when fertilized differently.

ON SOURCES OF ERROR IN FIELD SAMPLING OF CROPS FOR ANALYSIS, C. D. WOODS, B. S. (pp. 120-135).—With a view to studying the errors which may arise from sampling even when carefully done, "duplicate samples were analyzed from each plat of a soil test with maize,

and triplicate samples from each plat of a special nitrogen experiment with grass." The manner of taking the samples is described as follows:

Corn.—A representative bunch of four to eight plants was taken from every alternate stook [stacked in the field for some time] and put into a pile, taking about half of each sample from the exterior and half from the interior of the stook. The total sample thus obtained made a good-sized armful, varying in weight from 10 to 15 pounds. Three distinct samples were taken in this way from each plat [the different samples from each plat being taken by the same person].

Each entire sample was weighed and husked. The stalks from each separate sample were cut into about 1-inch lengths, and the whole, or very nearly the whole, taken for the laboratory sample. One half to two thirds of the ears, selected so as to represent the whole as fairly as possible, were taken for the final sample. The final samples were weighed, placed in cotton bags, and immediately shipped to the laboratory. * * * [In preparing the dried sample for analysis] the sample of stover was weighed and then cut into as short pieces as possible by means of a vertical hay-cutter, and carefully sampled. A sample of 3 to 4 quarts was ground, being put through the mill once. This was again carefully sampled, and enough to fill an 8-ounce bottle was taken and ground till it would pass through a round hole 1 mm. in diameter. * * * The [shelled] corn was carefully sampled and about a pint was ground, being put through the mill once. This was again sampled and treated in the same way as the stover above. The final sample filled a 4-ounce bottle.

Hay and legumes.—Representative handfuls were taken from each windrow [of the dried hay]. * * * The total sample weighed from 12 to 15 pounds, being about all that could be crowded into a bran sack. Three distinct samples were taken in this way from each plat. These large samples were cut into short lengths, and a final sample of about 4 pounds was selected from each, weighed, and put in a cotton bag for shipment to the laboratory. * * *

Several samples of legumes were taken by selecting for each an area of 4 square feet, the crop upon which seemed to fairly represent the average of the crop in the different parts of the plat or field, and cutting and taking the total yield of the 4 square feet for a sample. * * * The hay was prepared for analysis in the same way as stover. The entire sample of the legumes was ground, being put through the mill once. This was again sampled and ground till it would pass through a round hole 1 mm. in diameter.

Analyses were made of the duplicate samples of corn and stover from 10 different plats, of triplicate samples of the hay from 10 plats, and of duplicate samples of vetch, clover, and white, yellow, and blue lupines, the results of which are tabulated. The following condensed statement shows the extreme and mean differences between analyses of samples from the same plats.

Variation in composition of samples from the same plats.

	Corn.			Stover.			Hay.		
	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.
	Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
Water, at harvest	0.02	2.13	0.87	0.41	10.30	4.09	0.38	4.80	1.64
In water-free substance:									
Nitrogen	0.00	0.26	0.08	0.01	0.10	0.06	0.02	0.13	0.07
Fat	0.01	0.37	0.15	0.08	0.55	0.26	0.22	2.37	0.77
Fiber	0.01	0.11	0.05	0.09	1.73	0.72	0.15	1.26	0.71
Ash	0.01	0.13	0.07	0.10	0.82	0.50	0.15	0.34	0.23

"It will be observed that the variations in percentages of water and of most of the other ingredients in corn are much less than the variations in composition of either grass or stover." A comparison of the maximum differences between samples from the same plat with the maximum differences in the crops from the variously fertilized plats, are given as follows:

Variation in composition of samples from the same and different plats.

	Corn.		Stover.		Hay.	
	Between duplicate samples from same plat.	Between samples from different plats.	Between duplicate samples from same plat.	Between samples from different plats.	Between triplicate samples from same plat.	Between samples from different plats.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Water at harvest	2.13	2.96	10.30	18.65	4.80	8.37
In water-free substance:						
Nitrogen	0.26	0.20	0.10	0.20	0.13	0.30
Fat	0.37	0.30	0.55	0.64	2.37	1.15
Fiber	0.11	0.17	1.73	1.82	1.26	3.78
Ash	0.13	0.14	0.83	1.17	0.34	0.87

In the case of the corn there seems to be as great or even greater differences in composition of water-free substance of the crop due to errors of sampling than are due to the use of different fertilizers used in growing the crop on the different plats. This is also true, to quite an extent, of the stover. * * *

In the case of hay, the differences due to the effect of fertilizers were apparently greater than in that of the maize, and the differences in composition of the water-free substance of the crop from different plats were sufficiently large to be evident in spite of the errors of sampling. [In the case of duplicate samples of legumes analyzed] the variations are large.

To increase the size of the sample is doubtless the best way, all things considered, for reducing the errors of field sampling. The ideal way would be to analyze the total yield. The difficulty with large samples, such as the tenth of the yield of an ordinary plat, is in the handling of so much material. In the case of such plants as grass, oats, wheat, etc., where a sample of 10 or 15 pounds includes hundreds of individuals, it is not difficult to take samples that should be representative. In the case of maize a far greater weight would have to be taken to overcome errors.

Detailed directions are given for sampling maize, hay, and oats.

RIPENING OF CREAM, H. W. CONN, PH. D. (pp. 136–157).—In this paper the author reviews the literature relative to the composition and structure of cream, gives brief accounts of the studies of Storch in Copenhagen and Weigmann in Kiel on the part played by bacteria and other low organisms in the ripening of cream, and their effect on the quality of the butter made from ripened cream; and describes the investigations carried on by himself at Wesleyan University on the normal ripening of cream. From his review of what is known of the composition and structure of cream he concludes that "the verdict of science" is at the present time somewhat as follows:

The fat globules are not cellular in their structure. There is no good reason for believing that there is formed around them either before being drawn from the cow or afterward, anything in the form of a membrane. The permanent emulsion of the

milk is probably explained, largely at least, by the laws of liquids. The film of casein around the fat has a surface tension different from that of the fat, and this tension must be overcome in order that the fat globules may fuse together. Anything which would tend to rupture that film would assist in the fusion and aid the solution of the globules, and hence the addition of acids or a shaking will tend to make the fat globules fuse together. Lastly, it would seem that a change takes place in the milk shortly after being drawn. It becomes less liquid, and a slimy substance is formed, which causes the globules to unite together into groups. This substance may be fibrin, and is at all events of a proteid nature. In all cream of course this material will be present, and its presence is an important factor in the consideration of the treatment of cream in butter making.

The author's studies have been made on ripened cream from two different creameries and from the Storrs School dairy, and on cream ripened in the laboratory at different seasons of the year. His method of work is described in detail. He considers the estimation of the actual number of bacteria in cream as of very little value, since the number is so large (being estimated at 200,000–2,000,000 in a single drop the size of a pin head in some of the specimens studied) that anything like an approximation to accuracy is impossible.

I have found a larger number of bacteria in centrifugal cream than in the skim milk taken at the same time. The slime that collects on the drum of the machine was found to have more than either the milk or the cream. This is the same result as was reached by Wyss, who stated that this slime contained seven times as many bacteria as the milk. I did not find so great a numerical difference.

One of the chief objects in this study has been to determine how great a variety there exists in the bacteria found in normally ripening cream, and to see if there is any one or any few species which are distinctly characteristic of the process. * * * At least 50 different species or varieties of organisms have been isolated and studied, including bacteria, yeasts, and molds. Among them are many of the well-known forms described in bacteriological text books, but also a large number of forms which do not agree with any description that I have been able to find. * * * From this great variety we must conclude that the special series of forms of bacteria which are present in any specimen of ripening cream is more or less a matter of accident. In the cream there is a great battle of the forms with each other. The victors will be those which chance to get the best start, and this depends upon such a variety of circumstances connected with the collecting of the cream that it is entirely beyond our knowledge. No means at the command of the dairyman can regulate the bacteria supplied him by his customers nor the variety which produce the ripening of his cream. Uniformity in the ripening process does not occur even under seemingly uniform conditions. * * * The experiments in collecting the forms of bacteria found in ripened cream are still in progress and new varieties are being constantly found. I shall therefore reserve a special description of the individual species until it seems that a tolerably complete list of the common forms in cream can be given. It may be that a complete list can never be given, and that the forms are constantly undergoing modification. To determine this will of course require a long series of years. At the present time, at all events, the only statements of value which can be made are concerning the classes of physiological action shown by the various forms.

For convenience in description the author divides the forms into the three classes recognized by Adametz, *i.e.* (1) those causing the formation of acid in the milk, which precipitates the casein; (2) those curdling the milk without rendering it acid; and (3) those having no visible effect on

the milk. With regard to the bacteria of the first class, the author has not yet found any form which agrees exactly with *Bacillus acidi lactici*, described by Heuppe.

Several bacteria have been isolated which agree with it in most particulars, but in every case there has been some point of difference which has indicated that I have not had exactly the same form. The acid formed by the various members of this class is usually lactic acid, but acetic acid and formic acid have been found in some cases by Mr. Dains, who has made some chemical studies of my cultures.

[The bacteria of the second class all] liquify gelatin, and many of them produce spores. Butyric acid is one of the common by-products of the action on milk. * * * The curd formed is not hard and fragmented, but is soft and jelly-like or sometimes divided into fine flakes. It is further found that after a few days the curd begins to grow less in amount and a whey to appear. As the growth continues longer, the curd is seen to be slowly dissolved, and this gradual solution may continue until the curd is completely dissolved into a limpid liquid. The solution may, however, in some species stop short of completion, and there may be thus formed a quantity of liquid in which a small curd floats. The liquid formed differs widely in different cases. It is sometimes clear and sometimes cloudy. Sometimes it assumes an amber color, and in one case a brilliant yellow color was produced in the dissolved liquid. At other times the liquid becomes greenish. * * *

That the curdling of milk and the subsequent solution of the curd are processes independent of each other, is indicated by the following observations: * * * Among the species which I have isolated from cream two have been especially interesting in this connection. The first is an organism growing into long rods, which occasionally branch and break up into short, oval, yeast-like bodies. It has many points of resemblance to *Saccharomyces albicans*. This species has a very characteristic growth on gelatin, forming a layer resembling ground glass, and is easily distinguished from any other organism which I have found. When first studied it was found that at the ordinary temperature of the room it would not curdle the milk, but that it did slowly digest the casein. The milk became clear and transparent after a few days, appearing exactly like the peptonized curd of other species, but without the previous precipitation of the casein. When this species was grown in milk in a warm oven, at a temperature of about 35° C., the curdling appeared first, and the peptonizing subsequently took place. After several months of cultivation I found that this organism had lost its power of precipitating the casein. Even when growing in the warm oven the power of curdling the milk did not appear. The organism had, however, lost none of its morphological characters, and it still possessed the power of peptonizing the casein.

The second species is one of the forms of bacilli which would be included under the general name of *Bacillus fluorescens liquefaciens*. A number of liquefying forms seem to have the power of producing a fluorescent appearance in gelatin, and the above name probably includes several varieties. The variety which I have isolated and studied acted at first like ordinary liquefying organisms, curdling the milk rapidly and subsequently dissolving the curd. This organism was kept in the laboratory for several months and carried through a large number of cultures. After 3 or 4 months it was noticed that its power of curdling milk was becoming less marked, as it required a longer time or a higher temperature for this purpose. Finally it disappeared altogether. The digesting power was not lost, however, for the milk was peptonized as usual.

In these two cases it is plain that we have an indication of the independence of the two actions on milk, and see that one may be lost without the other. We can hardly be wrong then in assuming, with all experimenters, that these liquefying organisms produce two chemical ferments, one having an action similar to rennet and the other an action similar to trypsin.

The third class of organisms which I would distinguish has no visible effect on milk. This does not mean that they have no effect, for they grow rapidly and produce various odors, indicating that decomposition changes are going on in the milk. The milk occasionally becomes slightly acid, sometimes slightly alkaline, and sometimes the reaction is not affected. In no case, however, is the acid sufficient to curdle the milk. * * *

One of the most striking results of the growth of different bacteria in milk is the character of the odors of the decompositions which are produced. The subject is, however, too intangible to describe. We have no names sufficient to enable us to classify odors, nor have we sufficiently well-trained senses of smell to enable us to remember a new odor for a long time. It is certain that the odors produced in the different milk cultures are widely varied and give plain indications of the formation of numerous volatile products, but I have been entirely unable to classify them. These odors are important factors in producing the aroma of the butter which is made from the ripened cream. If it were possible to develop the discrimination of this sense of smell, and to create a language to go with it, it is likely that a new and important factor could be added to bacteriological investigations. * * *

It will be seen that the physiological action of the bacteria, as above outlined, will explain all of the characters of ripened cream. The souring is due, of course, to the formation of lactic acid by the acid-forming class of organisms. The slight thickening is due to a more or less complete precipitation of the casein in the form of a curd. The odor is due to a mixture of the volatile products of bacteria growth. The peculiar aroma so important to the butter is due to the same cause. The greater ease of churning sour cream is readily explained by the fact that either the acid formed by the bacteria or the trypsin-like ferment or both will tend to dissolve the protein mass (fibrin?) which we have seen holds the fat globules together. As soon as this fibrous mass is broken down the globules can more readily be shaken together so as to fuse into large granules.

Having reached this position it becomes desirable to study the effects upon butter of ripening the cream with different species of bacteria. If the right species may be found to be used as an artificial ferment for the ripening process, this process may be controlled, and if it can be controlled the irregularity of butter making may be eliminated. Experiments in this direction have been begun in connection with the dairy of the experiment station, but the work has not advanced far enough at present to give any definite results.

A MICROCOCCUS OF BITTER MILK, H. W. CONN., PH. D. (pp. 158–162).—Nine forms of bacteria were isolated from a sample of bitter cream, "one of which was found by subsequent experiments to be the cause of the bitter taste." It is explained that the bitter taste in milk has been supposed to be connected with the formation of butyric acid. Weigmann, however, has recently concluded that the bitter taste is due to a special bacillus which he isolated from bitter milk, and which, he says, does not produce butyric acid.

The author believes the organism isolated by himself from bitter cream to be different from the one found by Weigmann in bitter milk. The organism is described as "a good-sized micrococcus, having no tendency to form chains." It is immobile, white, aërobian, and liquefies gelatin rapidly, the resulting liquid being very slimy. Milk inoculated with it—

Curdled in one day in a warm oven. Becomes very bitter. The litmus solution which is added to the milk turns slightly red. Later the color of the litmus is

bleached. The curd which is formed soon begins to dissolve, though the solution is never quite complete. The liquid thus formed is slimy.

[In bouillon] its growth is abundant. A thin membrane forms on the surface. The bouillon becomes remarkably slimy, and can be drawn out into threads 10 feet long. Odor and taste like that of bitter milk.

When a quantity of bouillon in which the micrococcus had been growing for a couple of days was added to sterilized milk, adding chloroform at the same time to prevent further growth, the milk curdled in less than half an hour. "Since no bacterial growth ever produces curdling in so short a time, and since, moreover, the presence of chloroform prevents the bacteria growth, there is no question that in this case a chemical ferment must have been present in solution. I have not yet isolated the ferment."

Two separate trials were made in which cream was divided into two portions, one portion being allowed to ripen in the ordinary manner and the other inoculated with a "milk culture of the bitter organisms." Each cream was churned after ripening for 48 hours. In each of the trials the butter obtained from the inoculated cream "had a slightly rancid odor and taste, and had a very bad flavor. It leaves a strong, burning taste on the back of the tongue, which could be perceived for half an hour after the butter was swallowed. The butter was, in short, not fit to use."

The butter from the uninoculated cream "was a fair quality of winter butter." The samples were salted and their keeping qualities tested. "In two days the test butter was strongly rancid, and the taste was strong and burning. The control butter was only slightly changed.

"From these experiments it is plain that the bitter organism thus described is one which will prove an injury to the butter, and must be avoided in all attempts to obtain first quality butter." A test of the milk cultures of the organism indicated the presence of butyric acid.

On the Schulze-Tiemann method of estimating nitric acid, H. B. Gibson, B. A. (pp. 163-173).—The sources of error in the determination of nitric acid by this method are enumerated, and experiments reported which were intended to test the errors arising from (1) the absorption of nitric oxide by the caustic soda solution over which it is collected, and (2) the difference between the temperature of the nitric oxide and the surrounding water bath, where the modified Schiff azotometer is used. The indications of the experiments are summarized as follows:

Care should be taken to concentrate the solution of nitrates as much as possible before adding reagents. The reagents should be added in a very concentrated form, and the mixture allowed to digest well before heat is applied.

In passing nitric acid through solutions of caustic soda of various degrees of saturation, a saturated solution absorbs the least, but on standing over the same solutions it absorbs the most. In the use of the modified Schiff azotometer with a saturated solution of caustic soda most of the absorption is obviated.

That there is no hydrochloric acid gas carried over with the nitric oxide is highly probable; both from the fact that its presence is not detected by solutions of silver nitrate, and that the results obtained by collecting the gas over 10 per cent hydrochloric acid are lower than when the gas is collected over a saturated soda solution, and do not differ greatly from those obtained by collecting it over water.

Variations of temperature between the nitric oxide and the surrounding water of the water jacket are so slight that they may safely be neglected.

In a word, the greatest errors in the use of the Schulze-Tiemann method for estimation of nitric acid arise from careless manipulation or poor reagents rather than from absorption of nitric oxide when collected over a saturated solution of caustic soda, or from differences of temperature which occur when the temperature of the gas is assumed to be the same as that of the water surrounding the eudiometer of the azotometer.

THE FUEL VALUE OF FEEDING STUFFS, W. O. ATWATER, PH. D. (pp. 174–181).—This is a popular article on the functions of food nutrients and the potential energy of food rations as a means of measuring their nutritive value, with statistics as to the composition and potential energy of rations fed to cows by different farmers.

INVESTIGATIONS WITH THE CALORIMETER, H. B. GIBSON, B. A. (pp. 182–192).—The instrument and method of work are described; the results given of determinations of the "heats of combustion" in cane sugar, milk sugar, dextrose, starch, mannite, stearine, fat of beef, fat of sheep, fat of swine, butter fat, olive oil, and sperm oil; and the results for carbohydrates are compared with those found by Berthelot and by Stohmann.

METEOROLOGICAL OBSERVATIONS, C. S. PHELPS, B. S. (pp. 193–196).—Brief notes on the weather; a summary of the rainfall at 17 localities in the State during the 6 months ending October 31, 1890; and a summary of the observations at the station for each month of 1890. The yearly summary is as follows: *Pressure* (inches).—Maximum, 30.83; minimum, 29.36; mean, 30.01. *Air temperature* (degrees F.).—Maximum, 89; minimum, —4.6; mean, 46.6. *Humidity.*—Mean relative humidity, 78. *Precipitation.*—Total (inches), 48.87; number of days on which 0.01 inch or more of rain fell, 144. *Weather.*—Number of clear days, 105; number of fair days, 139; number of cloudy days, 121.

Florida Station, Bulletin No. 14, July 1, 1891 (pp. 42).

ANNUAL REPORT, 1891, J. P. DEPASS.—This is for the year ending June 30, 1891, and includes general statements regarding the work of the station; brief notes on peaches, pears, Japanese plums, grapes, apples, the Japanese persimmon or kaki, watermelons, muskmelons, strawberries, cabbages, beets, eggplants, the McNeil pea, oats, and grasses; accounts of the horses, cows, pigs, and chickens kept at the station; financial statement; reports of the work in chemistry, by J. M. Pickell, Ph. D. and J. J. Earle, B. A.; notes on insecticides, with formulas; and a brief report on pineapples, by L. C. Washburn, M. D., superintendent of the substation at Fort Myers.

Georgia Station, Bulletin No. 14, October, 1891 (pp. 20).

EXPERIMENTS IN THE CULTURE OF OATS AND WHEAT, R. J. REDDING (pp. 73–78).—*Fertilizers on oats* (pp. 73–75).—An experiment on 10 tenth-acre plats to study the needs of the soil for growing oats. The soil, a "gray, gravelly soil, with hard red clay subsoil, made a fair crop of oats in 1890, followed immediately by peas, which were converted into hay. * * * The unaided productiveness of the soil increased from plat 1 throughout the series, plat 1 being of poorer quality than any." Nine of the plats received all three of the essential fertilizing ingredients in varying amounts, supplied in the form of superphosphate, muriate of potash, and cotton-seed meal; one plat remained unmanured. Three bushels of Appler oats per acre were sown on all the plats. The results as tabulated "indicate very decidedly that nitrogen is the most effective element as a fertilizer for oats on this land. In this case the cotton-seed meal was the only element which paid a good profit on cost, whether in single, double, or treble doses (32, 64, and 96 pounds per plat). The experiment was not sufficiently elaborate to indicate just what proportions of the different elements would give best results."

Tests of varieties (p. 75).—Tabulated notes on Appler and Texas Rust-Proof oats.

Culture of oats and wheat (pp. 76–78).—Brief recommendations for the seeding, growing, and manuring of oats and wheat.

Tests of varieties of wheat (p. 76).—Tabulated notes on 10 varieties.

EXPERIMENTS IN THE CULTURE OF VEGETABLES, G. SPETH (pp. 79–90).—*Tests of varieties of bush beans* (pp. 79, 80).—Tabulated notes on 20 varieties.

Fertilizer test with bush beans (pp. 81, 82).—The land used for the trial was a young pear orchard in which the trees were set the previous year. The soil was a sandy clay underlaid by heavy clay subsoil. The experiment included 24 rows each "an eighth of an acre long." On these superphosphate 400 pounds, muriate of potash 100 pounds, and cotton-seed meal 400 pounds or nitrate of soda 200 pounds per acre were used singly, two by two, and all three together; all three together with double the above amounts, applying the nitrogenous fertilizers either all at once or in two separate portions; and barnyard manure 15,000 pounds used alone. Four plats remained unmanured. Early Valentine beans were planted in hills a foot apart on all the plats. The yields of beans at four separate pickings are given for each plat. According to these the total yields of the four unfertilized plats ranged from 1.54 to 4.07 pounds per plat. The yields were larger when nitrogenous fertilizers were used alone or combined than where muriate of potash and superphosphate were used, either alone or combined, without nitrogen. Where no nitrogen was used the yield was about the same as on the unfertilized plats. The largest yield (8.47 pounds per plat) occurred where

400 pounds of superphosphate and 100 pounds of muriate of potash were used with a mixture of 100 pounds of nitrate of soda and 200 pounds of cotton-seed meal. In general no considerable increase in yield followed the use of double amounts of fertilizers.

Fertilizer tests with beets (pp. 82, 83).—The soil and fertilizers were the same as in the preceding experiment. Early Blood beets were sown in rows, and thinned to a distance of 10 inches apart. The weight of roots and leaves from three average beets on each plat are tabulated.

The nitrate-of-soda plats, either in single or double rations, showed a decided gain over cotton-seed meal, which may be credited to the immediate availability of nitrogen in such form as to be readily assimilated by the growing plant, while the effect of cotton-seed meal in early spring is slow, which will naturally lead us to the conclusion that for quick-maturing crops, especially those planted very early in the spring, nitrate of soda should form the source of nitrogen.

Double rations of nitrogenous ingredients in most cases increased the size of the roots, as well as the earliness—the greatest consideration for market gardeners.

Test of varieties of English peas (pp. 84, 85).—Tabulated notes on 28 varieties.

Fertilizer tests with peas (p. 86).—The soil and fertilizers were practically the same as in the preceding experiments with beans and beets, except that no barnyard manure was used. The variety sown was Blue Beauty. The yields at four successive pickings are tabulated. The yields were larger with than without nitrogenous fertilizers, and as between the two forms the results were favorable to nitrate of soda. The largest yields occurred where muriate of potash, superphosphate, and nitrate of soda were combined.

Tests of varieties of cantaloupes (pp. 87, 88).—Descriptive notes on 18 varieties.

Fertilizer test with cantaloupes (pp. 89, 90).—"The object of the experiment was to determine the effect of nitrate of soda and cotton-seed meal in different combinations and rations on earliness and productiveness," the combinations and amounts of fertilizers used being very similar to those in the preceding experiments. The land used was an old orchard. Each of the 19 plats included one row "a quarter of an acre" long, the rows being 6 feet apart. Nixon was the variety used on all the plats. The tabulated results "point toward the beneficial effect of nitrate of soda in regard to earliness, while cotton seed meal, in almost every combination, increased the yield at the expense of earliness."

Kansas Station, Bulletin No. 24, September, 1891 (pp. 12).

ENZOÖTIC CEREBRITIS OF HORSES, N. S. MAYO, D. V. S. (pp. 107–116, plate 1).—During the autumn and winter of 1890–91 a disease popularly designated "staggers" caused the death of a considerable number of horses in Kansas and adjoining States. This article gives an account of investigations of the disease by the author. The symptoms and the results of post-mortem examinations are given. A feeding

experiment with a 2-year old colt indicated that the disease was caused from eating corn affected with a mold—*Aspergillus glaucus.* The appearance of ears of corn attacked by this mold is illustrated in the plate accompanying the article. Experiments by Kaufmann and others in France and Germany, in which the death of rabbits was caused by inoculation with the spores of this mold, are briefly described. The author inoculated a guinea pig with spores of the same mold, with fatal results. Other outbreaks of what may have been this same disease in horses are described by references to the publications of this Department. The following summary is taken from the bulletin:

The disease variously known as "staggers," "mad staggers," etc., as occurring in Kansas during the past fall and winter, is caused by feeding corn which has been attacked by a mold—*Aspergillus glaucus.* The spores of this mold gain entrance to the circulation and find lodgment in the kidneys and liver. The liver is more affected than the kidneys (probably on account of the lower pressure of the circulation). The spores germinate here, and cause inflammation of these organs. The cerebral symptoms are the result of the formation of an abscess in the cerebrum. This abscess is caused by an interference with the blood supply, probably from spores or mycelia of the mold in the circulation. The spores of *Aspergillus glaucus* seemed to retain their infectious properties for about 6 months, from October, 1890, to March, 1891. Neither mules, cattle, nor pigs contract the disease.

Treatment.—In this disease an ounce of prevention is worth many pounds of cure. The method of prevention is obvious: Do not feed moldy corn or turn horses into fields where moldy corn can be had. In feeding ear corn from the crib care should be exercised to pick out the moldy ears or break off the moldy tip. In case the corn has been shelled, it can be poured into water, and the moldy kernels, floating, can be skimmed off.

After an animal has been taken sick treatment is very unsatisfactory. The animal should be kept as quiet as possible, in a clean, dry, well-ventilated, and strong box stall. A purgative may be given of about 7 drams of aloes. One dram of iodide of potash or 3 drams of bromide of potash can be given in sufficient water every 3 hours, and cold applications to the poll by means of wet cloths are helpful. In case the spinal cord is affected a moderate blister can be applied along the spine. Care should be taken to excite the animal as little as possible and to avoid choking it in giving medicines, as it is often difficult for the animal to swallow.

Louisiana Stations, Bulletin No. 11 (Second Series), (pp. 34).

REPORT OF THE SUGARHOUSE AND LABORATORY OF THE SUGAR EXPERIMENT STATION FOR 1890, W. C. STUBBS, PH. D. (pp. 248–278).—Descriptions are given of the sugarhouse at Audubon Park, New Orleans, and its equipment; and especially of the diffusion battery and the process of making sugar by diffusion. The results of twelve runs with the diffusion battery, from November 11 to December 8, inclusive, are tabulated. The percentage of extraction in sugar in the cane ranged from 93.58 to 98. Tabulated data are also given for the results obtained with different methods of clarification, (1) lime alone; (2) lime and bisulphite of lime; (3) lime and acid phosphate of calcium; (4) lime and sulphur; (5) Wilcox's albumen process; (6) lime, sulphur, and acid phosphate of calcium; (7) sulphide of alumina; (8) superphosphate of alumina.

Wilcox's process with albumen showed no special merit, with the decided objection of time required to perform the different operations. * * *

For diffusion juice coming hot from the battery, which takes sulphur with difficulty, the acid phosphate of calcium seems specially adapted. By liming to excess in the cells and neutralizing the juices at once in the clarifier with acid phosphate of calcium, excellent results are obtained. In mill houses where sulphuring precedes the lime, the application of acid phosphate is not so easy nor so rapid. It is therefore of doubtful utility in these houses, especially at its present price. * * *

The use of alum, sulphate of alumina, and superphosphate of alumina are, from our experience, to be strongly condemned as not only injurious to the juice, but strongly resistant to every effort of rapid settling.

The trial of Fancher and Clarke's process for the conversion of molasses into sugar showed that there was no advantage to be gained by the use of this method.

Investigations in the sugarhouse and laboratory showed that—

Whenever a solution of glucose, dextrose, or levulose is treated with an excess o lime, a darkening of the solution takes place with the conversion of these substances into acids which gradually neutralize the lime, until finally if enough lime be present the entire glucose is destroyed and there remains in the black solution soluble salts of lime. These acids have been named glucinic and saccharic, and they form with lime soluble salts. When the lime is precipitated from these solutions the acids are left in a free state ready to destroy the sucrose whenever heat is applied. Could some way be found to precipitate these acids after precipitating the lime, valuable results could be obtained from this process, but unfortunately the only precipitant of these acids (oxides of mercury) are poisons and can not be used in the arts.

Experiments with reference to the influence of wash water on the centrifugal are reported which lead to the following conclusions:

(1) Massecuite in cooling gives a greater yield in the centrifugal, and suggests the propriety of the method adopted by many planters, of dropping their massecuite into wagons and keeping for several hours in the hot room.

(2) Mixing the water with massecuite before centrifugaling gives larger yields than using the same amount in the centrifugal.

(3) For every pound of water used in the centrifugal more than a pound of sugar is dissolved.

Analyses of the mill juices obtained from cane grown on plats fertilized with different substances, as reported in a table, indicate that little or no influence was produced by the fertilizers on the ash and albuminoids of the juice. The analysis of the "final" molasses obtained from cane grown on the different plats is also given. Investigations of the compounds for bleaching molasses sold under the name of "sulphine" and "boxyde" are reported. The boxyde was found to be zinc dust, and sulphine to be a solution of commercial bisulphite of soda with a small quantity of sulphuric acid. When used together they have proved efficient agents for bleaching molasses.

Maine Station, Annual Report, 1890, Parts III and IV (pp. 39 and 68).

RELATIVE YIELD OF DIGESTIBLE MATERIAL IN EARLY-CUT AND LATE-CUT TIMOTHY HAY (pp. 65–67).—In this trial 14 plats were used, 10 of which were 30 by 50 feet each, and the remaining 4, 33 by 90 feet. The grass on one half of each plat was cut July 1, when the timothy was in full bloom, and that on the other half July 18. The hay from each cutting was weighed at the time of putting in the barn and again the following April, analyzed, and its digestibility determined with sheep, two animals being fed the early-cut hay, and two others the late-cut hay during 5 days. The yield of hay per acre, shrinkage in keeping, composition, and percentage of digestibility are tabulated for both cuttings.

The yield per acre of the grass cut on July 1 was 4,225 pounds of dry hay, and of that cut July 18, 5,086 pounds. As would be expected from all previous analyses, the early-cut hay proved to be the more nitrogenous and also the more digestible. From the early-cut hay 56.07 per cent of the organic matter was digested and from the late-cut hay only 50.7 per cent. Of total digestible material the late-cut hay proved to contain the more, the amounts per acre being, early-cut 2,028 and late-cut 2,212 pounds. These figures stand somewhat in opposition to those obtained from the crop of 1888, where the larger amount of digestible material was obtained from early-cut hay.

FEEDING EXPERIMENTS WITH COLTS (pp. 68–70).—An experiment with three grade Percheron colts, 9, 16, and 18 months old, respectively, to compare oats *vs.* a mixture of pea meal and wheat middlings. The rations were from February 13 to April 2, hay and 6 to 8 pounds of a mixture of one third pea meal with two thirds middlings; April 3 to May 28, hay and 6 to 8 pounds of oats; May 29 to July 2, hay and 6 to 8 pounds of a mixture of 1 part of pea meal and 4 parts middlings. The food consumed and gain in weight are given for each colt during each of the three periods, but the cost of the rations is not considered. "The growth of the colts was somewhat irregular," but "the outcome of the experiment is such as to show no superiority for the oats as food for producing growth merely. In fact if anything is indicated it is that the advantage was with the mixture of peas and middlings."

FEEDING EXPERIMENT WITH STEERS (pp. 71–74).—This included Holstein, Shorthorn, and Hereford steers, two of each, ranging in age from 5 to 8 months, and was designed to compare the growth of the three breeds on the same rations, and to compare the effects of two rations having different nutritive ratios when fed for a long time. One steer from each breed was fed hay and a grain mixture consisting of equal parts of cotton-seed meal, ground oats, and wheat bran; the others received hay and a grain mixture composed of equal parts of corn meal, ground oats, and wheat bran. The hay was fed *ad libitum;* of the grain mixtures, 3 pounds per animal per day was given during the first 5 months, and after that 4 pounds. The nutritive ratio of the corn-meal ration was about 1:10; that of the other about 1:6.7. Serious accidents occurred to three of the steers, which prematurely terminated the

comparisons. The results are tabulated for 233 days, from November 7 to June 27. The total gain made by the three steers on the cotton-seed-meal ration was 1,150 pounds, and by those on the corn-meal ration 1,145 pounds. There was practically no difference in the amount of coarse fodder consumed by the two lots. No comparison of breeds is attempted, but the amount of digestible nutrients consumed per 1,000 pounds live weight daily by the two lots is calculated, and these figures are compared with the German standard recommended for animals under similar conditions.

In no instance was the total amount of digestible nutrients so large as called for in the standard rations, and there was no case where the proportion of digestible protein was as large. In three cases the amount of protein fell very much below the theoretical ration. * * *

It can not be doubted that the experiment adds much to the increasing volume of testimony that for growing animals so large an amount of digestible protein is not necessary as is called for by the German standards.

Feeding experiment with different breeds of swine (pp. 75–78).—The breeds represented were Berkshire, Cheshire, Poland-China, Chester White, and Yorkshire. There were two pigs of each breed, one male and one female, both from the same litter, and the age at the beginning of the trial ranged from 5 to 8 weeks. The food given consisted of skim milk and wheat middlings, the proportion of the latter being gradually increased to the end of the trial, when very little milk was fed. A small amount of Hungarian grass and corn fodder were also fed during one period. The feeding lasted from 175, to 210 days with the different breeds. The food consumed, gain in weight, and the relation between gain in weight and amount of food consumed are tabulated for each breed.

In general no striking differences are observed in the rate of growth, or in the relation of the amount of food to growth, with these several breeds of swine.

The daily rate of growth of our animals is seen to have been, Cheshires 1.23 pounds, Yorkshires 1.11 pounds, Chester Whites 1.08 pounds, Poland-Chinas 1.01 pounds, Berkshires 1 pound.

It does not appear that the animals growing most rapidly required the least food for a pound of growth. * * * Although the Berkshire pigs made the smallest gain they required the least food for each pound of growth, and the Cheshires, making the largest gain, consumed the most food for each pound of increase of weight. * * *

The ratio of food to growth was very different during the early part of the experiment from what it was the latter part. In period 1, including approximately the first 100 days of the experiment, not far from 2 pounds of digestible food produced 1 pound of growth, while during the last 50 days or thereabouts the ratio was 4 pounds of digestible food to 1 pound of growth. The ratio of the second period stands between those of the first and third. * * * Certain of the animals, notably the Berkshires and Chester Whites, made during the first 3 months a larger percentage of their entire growth than did the other breeds. The difference, however, is not very marked.

Fertilizer experiments, W. Balentine, M. S. (pp. 79–101).

Effects of different forms and mixtures of fertilizers (pp. 79–89).—This is

a continuation of an experiment commenced at the station in 1886 on 36 twentieth-acre plats for the purpose of comparing the effects of (1) different forms of phosphoric acid (dissolved boneblack, fine-ground bone, and fine-ground South Carolina rock), (2) commercial fertilizers *vs.* barnyard manure, (3) partial *vs.* complete fertilizers, and (4) different quantities of fertilizers. A description of the land and of the fertilizers used was given in the Annual Report of the station for 1888 (see Experiment Station Bulletin No. 2, part II, p. 48). The crops grown were oats in 1886 and 1887, oats and grass in 1888, and corn in 1889, the latter crop being a failure. Fertilizers were applied in 1886, 1887, and 1889, the respective plats receiving the same fertilizers from year to year. In 1890, the fifth year, peas were grown and no fertilizers were applied on any of the plats. The yields of peas and straw on the various plats are fully tabulated, together with the financial results.

The table shows that of the phosphates applied to this field with this crop, fine-ground bone gave the highest yield of peas, while dissolved boneblack stood next, the lowest yield being with South Carolina rock. The table also shows that muriate of potash and sulphate of ammonia have little or no effect when applied alone, and that by far the largest yield of peas was obtained from the plats manured with stable manure. * * *

The average yield of the plats to which no manure was applied is practically the same as the average yield of those plats which were manured with [a mixture of] muriate of potash and sulphate of ammonia. The plats manured with dissolved boneblack show a decided increase over the unmanured plats [the combination with muriate of potash giving the largest yield]. * * *

This experiment shows quite clearly that for the soil on which the experiment was carried out and for this crop, the nitrogenous manure was not needed, and that it only served to increase the cost of the crop. * * *

[Where complete fertilizers were used] in no case was the increased yield sufficient to pay for the cost of the fertilizers.

Systems of manuring (pp. 89–96).—This experiment was intended to compare barnyard manure with commercial fertilizers and with no manure in crop production. In 1888 a ten-acre field of clay-loam grass land was divided into 4 equal plats and for 2 years no fertilizers were applied to any of the plats. The grass was cut and weighed each year to determine the relative fertility of the plats. The average annual yield of hay per acre was as follows: Plat 1, 2,542 pounds; plat 2, 2,416 pounds; plat 3, 2,082 pounds; and plat 4, 2,510 pounds. In 1890 the entire field was plowed and the following fertilizers applied: Plat 1, 50 loads (3 loads to the cord) of cow manure; plat 2, 2,500 pounds fine-ground South Carolina rock, 250 pounds muriate of potash, 165 pounds nitrate of soda, and 40 pounds ammonium sulphate; plat 3, 1,250 pounds dissolved South Carolina rock, and otherwise the same as plat 2; and plat 4, no manure. Barley was sown broadcast on one half of each plat; the remaining half plats (1¼ acres each) were each divided into two equal parts, small Canada peas being drilled in on one half and Black-Eyed Marrowfat peas on the other half. "The season was very unsatisfactory for experimental work, both at the opening and at the close,

on account of heavy rains." The yields are tabulated for each plat and each subplat.

[Considering first the total yield of barley and peas for each plat] the highest yield is given here with stable manure. Then follows the plat to which the fine-ground South Carolina rock was applied. Next in order comes the plat receiving acid South Carolina rock, while the lowest in the scale is the unmanured plat. * * * Plats 2 and 3 were treated alike as to fertilizers, excepting in the amount and condition of phosphoric acid. Plat 2 received about 200 pounds of insoluble phosphoric acid per acre, while plat 3 received 70 pounds of soluble phosphoric acid per acre. It would seem from these results that [in this season] the 200 pounds of insoluble phosphoric acid was more effective in producing an increase in the total weight of the crop than the 70 pounds of soluble phosphoric acid.

The yield per acre of barley and the 2 varieties of peas is given as follows:

Yield of barley and peas per acre with different fertilizers.

Fertilizers.	Barley.		Black Eyed peas.		Canada peas.	
	Grain.	Straw.	Peas.	Vines.	Peas.	Vines.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Barnyard manure	441	2,766	648	920	318	1,314
Mixed fertilizer containing ground South Carolina rock	442	2,216	522	520	203	697
Mixed fertilizer containing dissolved South Carolina rock	434	1,438	402	720	195	596
Unmanured for 3 years	176	1,048	411	658	256	688

In whatever light the figures be examined we can but come to the conclusion that the ground South Carolina rock has assisted in increasing the crop of barley to an extent nearly equal to, if not greater than acid South Carolina rock. * * *

Under the conditions of this experiment the growing of peas for stock purposes is to be preferred to growing barley. The Black-Eyed Marrowfat pea yields double the amount of the Canada pea.

Fertilizer experiments by farmers (pp. 96–101).—Experiments were carried on by two farmers to compare the effects of South Carolina rock, both dissolved and finely ground, with those of Thomas slag when used alone or in combination with 150 pounds of nitrate of soda and 100 pounds of muriate of potash per acre. One thousand pounds of Thomas slag and 500 pounds of dissolved or 1,000 pounds of fine-ground rock phosphate per acre were used. One plat received in addition to the ground rock phosphate "an amount of free lime [200 pounds per acre] equal to that contained in the Thomas slag." The fertilizers were furnished by the station. Each experiment was on tenth-acre plats. The soil of one farm was "a heavy, rocky loam, with yellow subsoil and a hardpan from 2½ to 3 feet below the surface." Corn was the crop grown in this case, and on the other farm, the soil of which is not described, potatoes were grown.

[In the former case] slightly more corn was produced with Thomas slag than with acid South Carolina rock. The experiment gives no evidence that the superior effect of the Thomas slag over fine-ground South Carolina rock is due to the free lime contained in the slag.

[In the latter case] the crop was doubled by adding 150 pounds of nitrate of soda and 100 pounds of muriate of potash. * * * No addition to this crop was produced by using South Carolina rock or Thomas slag. But the use of 500 pounds of acid South Carolina rock, costing $4.50, caused an additional gain to that made by the nitrate of soda and muriate of potash of 56 bushels, at a cost of 8 cents per bushel.

The yields are also given of a crop of beans raised by Mr. H. L. Leland, in 1890, without fertilizers, on plats which in 1889 had been used for the comparison of fine-ground (1,000 pounds) or dissolved (500 pounds) South Carolina rock and Caribbean Sea guano (725 pounds), described in the Annual Report of the station for 1889, pp. 135–144 (see Experiment Station Record, vol. II, p. 648). The soil is described as "a dry, slaty loam, which previous to 1889 had received no manure for 30 years, had been subjected to continuous cropping," and had proved to be quite even in fertility. The phosphates were applied in combination with muriate of potash and nitrate of soda, as in the experiments of 1890, described above. In 1889 the largest yields of potatoes were with dissolved rock, the next largest with fine-ground rock, and the next with guano. The yield of beans on these plats in 1890 followed the same order.

TESTS OF VARIETIES OF VEGETABLES, W. BALENTINE, M. S. (pp. 102, 103).—Notes on 6 varieties of beans, 3 of sweet corn, 1 of peas, and 1 of beets.

REPORT OF BOTANIST AND ENTOMOLOGIST, F. L. HARVEY, M. S. (pp. 105–140, plates 2, figs. 13).—The subjects considered are, (1) germination tests of seed, (2) tests of varieties of grasses, (3) suggestions regarding spraying experiments for apple scab and codling moth, (4) spraying experiments with Paris green for potato beetles, (5) discussion of causes of potato scab, (6) correspondence about strawberries, (7) notes on rib grass and fall dandelion, (8) notes on insects, (9) a list of varieties of orchard fruits and grapes planted at the station in 1890.

Germination tests of seeds (pp. 107–112).—Tabulated data for tests of vegetable seeds, the results of which have varied widely. Experiments in treating seeds with weak solutions of corrosive sublimate (1 part to 500 or 1,000 parts of water) to prevent injury by fungi have indicated that the treatment destroys the fungous germs, but in some cases may have injured the seed.

Spraying experiments with Paris green for potato beetles (pp. 114, 115).—A brief account of experiments in which solutions containing from $\frac{1}{4}$ to $1\frac{1}{2}$ teaspoonfuls of Paris green to 2 gallons of water were used for the potato beetle (*Doryphora decemlineata*). The solution containing 1 teaspoonful of Paris green was effective, but weaker solutions did not prove so.

Causes of potato scab (pp. 115–117).—A discussion of the results of investigations by H. L. Bolley of the Indiana Station, reported in Agricultural Science for September and October, 1890, and R. Thaxter of

the Connecticut State Station, reported in Bulletin No. 105 of that station (see Experiment Station Record, vol. II, p. 490).

Notes on rib grass and fall dandelion (pp. 119, 120).—Descriptions of *Plantago lanceolata* and *Leontodon autumnalis*, illustrated with drawings by Kate Furbish.

Notes on insects (pp. 121–139).—Illustrated accounts of the following insects more or less prevalent in Maine in 1890: Cecropia emperor moth (*Platysamia cecropia*), white-marked tussock moth (*Orgyia leucostigma*), fall webworm (*Hyphantria cunea*), eye-spotted bud moth (*Tmetocera ocellana*), woolly louse of the apple (*Schizoneura lanigera*), red-humped apple tree caterpiller (*Œdemasia concinna*), fall cankerworm (*Anisopteryx pometaria*), and forest tent caterpiller (*Clisiocampa disstria*).

REPORT OF METEOROLOGIST, M. C. FERNALD, PH. D. (pp. 141–157).—This includes monthly summaries of observations from April to October, inclusive, with hygrometers, soil thermometers, terrestrial and solar radiation thermometers, and on the amount of sunshine, velocity of the wind, and rainfall, together with a daily record of the observations for the month of July. Four hygrometers were used, two in an open field and two in a forest. From observations in 1889 and 1890 it appears that the excess of moisture in the forest above that in the open field at 7 a. m. was 5 per cent, at 1 p. m. 15 per cent, at 7 p. m. 10 per cent. Soil temperatures taken at depths of from 1 to 36 inches gave the following indications:

The mean daily range at the depth of 1 inch during the period of observation was 5.62°, at 3 inches 5.26°, at 6 inches 1.90°, at 9 inches 1.18°, and below 12 inches very slight.

At the depth of 3 inches the average temperature of the soil was somewhat higher than at the depth of 1 inch. The surface soil averaged about 5° warmer than the soil 36 inches below the surface. * * *

Comparing soil temperatures with air temperatures during the two seasons under notice the following mean results appear: At the depth of 1 inch the temperature of the soil was lower than that of the air by 2.40°; at the depth of 3 inches, by 2.11°; 6 inches, by 3.16°; 9 inches, by 3.91°; 12 inches, by 4.18°; 24 inches, by 5.78°; and at the depth of 36 inches, by 7.10°.

The mean loss of heat by radiation for the seasons of 1889 and 1890 was 6.48°. The greatest range observed was 19.5°. The average excess of temperature as determined by the solar radiation thermometer over the maximum temperature recorded by the thermometer in the shade was 60°. The average amount of sunshine in 1890 was 41 per cent. The average velocity of the wind in 1889 was 8.02 miles per hour; in 1890, 8.34 miles. The total rainfall in 1889 was 18.85 inches; in 1890, 35.52 inches.

REPORT OF TREASURER, G. H. HAMLIN.—This is a statement of receipts and expenditures for the fiscal year ending June 30, 1890.

REPORT OF DIRECTOR, W. H. JORDAN, M. S.—Brief statements regarding the work of the station in fertilizer inspection, field experiments

with fertilizers, and tests of breeds of dairy cows. The mailing list of the station has increased to about 5,700 addresses. A forcing house for plants has been erected, and it is intended to add a horticulturist to the station staff.

Maine Station, Bulletin No. 3 (Second Series), (pp. 8).

THE BABCOCK MILK TEST ADAPTED TO TESTING CREAM, J. M. BARTLETT, M. S. (figs. 3).—The author remarks on the variability of the fat content of cream, and cites tests which he has made of several samples of cream obtained from a creamery agent. "The lowest yield of fat was 12 per cent and the highest 30 per cent. Most of the samples gave from 17 per cent to 22 per cent. If this creamery had allowed equal amounts of butter for every inch of cream a great injustice would have been done to some of the patrons."

A description is given of the Babcock centrifugal milk test, and a proposed modification of the apparatus for testing cream. This modification consists in using a bottle with the graduated neck sufficiently long to allow the testing of cream containing up to 25 per cent of fat. In another form used for testing richer cream (up to 35 per cent of fat) the graduated part is made detachable, as the bulb is the part most likely to be broken. For this longer tube, however, a larger-sized centrifuge is necessary, as the ordinary one will not contain the tubes. The tubes are illustrated and directions are given for obtaining and using the apparatus. The author's recommendations for sampling sour cream which has curdled so that it can not be accurately measured with the pipette, are as follows:

> Place the jar containing it in water and heat the whole to about 125° F., then pass the cream through fine wire gauze (a flour sieve will do very well for the purpose). Any lumps that remain on the sieve may be rubbed through with the finger. After passing the warm cream through the sieve two or three times, it will, after cooling, be in condition to measure with the pipette. On account of the small particles of curd, sour cream adheres much more to the walls of the pipette than sweet cream, therefore a little water (4 or 5 c. c.) must be used to rinse the pipette into the test bottle. Unless this is done the results will be from 0.2 to 0.4 per cent too low. About 20 c. c. of acid should be used when the pipette is rinsed. When the cream is frothing badly and contains a large amount of air or gas bubbles, as is sometimes the case with cream that is very sour or taken from a separator, it can not be accurately measured but must be weighed. The writer has made several tests when the error in measuring frothy cream was over 5 per cent of the total fat.
>
> The only accurate method to pursue in such cases is to weigh the cream, and this can be very easily done by any one who has skill enough to make the test.

Massachusetts Hatch Station, Meteorological Bulletins Nos. 34 and 35, October and November, 1891 (pp. 4 each).

A daily and monthly summary of observations for October and November at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

Michigan Station, Bulletin No. 77, November, 1891 (pp. 6).

PERMANENT VS. RECENTLY SEEDED MEADOWS, W. J. BEAL, PH. D.—A report on experiments on stiff clay land which had been continuously pastured for 25 years or more. In 1888 a number of plats, 30 feet square, were sown with grasses and clovers, singly or in mixtures. Other plats were left in permanent meadow. The yields from the several plats in 1890 and 1891 are given in a table. The results varied considerably in the 2 years. Alsike clover, orchard grass, tall oat grass, and perennial rye grass have run out to a greater or less extent. The land is also not adapted to alfalfa. The average yield of the natural sod (timothy, June grass, and redtop) was comparatively light. Relatively large yields were obtained from tall meadow fescue, red clover, timothy, and mammoth clover. By far the largest yield was from a mixture of timothy, tall oat grass, orchard grass, tall fescue, fowl meadow grass, red and mammoth clover, and *Agropyrum tenerum*.

Mississippi Station, Bulletin No. 16, September, 1891 (pp. 15).

GLANDERS, T. BUTLER, D. V. S.—A popular account of the history, causes, transmission, symptoms, and treatment of glanders.

New York State Station, Ninth Annual Report, 1890 (pp. 488).

REPORT OF EXECUTIVE COMMITTEE (pp. 1–3).—A statement of repairs made and buildings erected, a brief outline of plans, and a recommendation that the State appropriation for carrying on the work of the station be increased to $30,000 annually.

REPORT OF TREASURER, W. O'HANLON (pp. 4–6).—A financial exhibit for the year ending September 30, 1890.

REPORT OF DIRECTOR, P. COLLIER, PH. D. (pp. 7–121).

Feeding experiments with milch cows (pp. 8–20).—The results are recorded for a test with one Jersey cow fresh in milk, which was fed hay, wheat bran, and corn meal during 3 months, the corn meal being partly replaced at different times by cotton seed meal or palm nut meal.

There appears to be no relation between the albuminoid constituents of the food digested and the amount of fat secured in the milk. There is, upon the other hand, especially during the fourth to seventh periods, [when palm nut meal was fed,] a pretty close relation between the fat in the food and that recovered in the milk, the food during these periods having contained over 95 per cent of the fat found in the milk. * * *

[From the tabulated yield of mornings' and nights' milk throughout the trial it appears] that while during the entire period the quantity of milk hourly secreted was practically the same during the day and night, the amount of fat secreted was, upon an average, 11½ per cent greater during the hours of the day than during those of the night.

[In another case in which a Jersey cow was fed on wheat straw and corn meal, the latter being partially substituted by gluten meal, and later on hay with corn meal and wheat bran, the results showed] no relation between the quantity of milk

produced or the amount of fat in the milk and the nitrogenous constituents of the food, since the increase of the albuminoids in food by nearly 200 per cent was without effect in increasing the amount of milk or its butter content. It is also in this experiment at least noteworthy that the amount of fat in the food during the first seven periods (unfortunately analyses were not made of milk during the last two periods) is identical with the amount found in the milk produced during these same periods.

The results are cited of a 4-days' test with 9 cows representing 5 different breeds, which "show that the amount, by weight, of milk secreted from 5 p. m. to 5 a. m. was about the same as that secreted from 5 a. m. to 5 p. m., the average being "only 0.6 per cent more during the day."

Experiments in fattening steers (pp. 20–45).—The data are tabulated for 5 steers of different breeds and different ages, fed various rations from April, 1889, to October, 1890.

Food values of feeding stuffs (pp. 46–61).—Reprinted as Bulletin No. 31 of the station (see Experiment Station Record, vol. III, p. 89).

Miscellaneous (pp. 62–121).—This includes accounts of the 4-days' dairy school held at the station during the year; the work at the station on grasses; the fertilizer control, including a reprint of Bulletin No. 25 of the station (see Experiment Station Record, vol. II, p. 366), to which are added analyses of 35 samples of commercial fertilizers; brief statements as to the work in progress at the station; an abstract of an address on the future of American agriculture; a list of the bulletins published during the year; and acknowledgment of gifts to the station.

REPORT OF FIRST ASSISTANT, W. P. WHEELER (pp. 122–169).

Experiments with poultry (pp. 122–140).—This contains in addition to an account of experiments in poultry feeding reported in Bulletin No. 29 of the station (see Experiment Station Record, vol. III, p. 36), accounts of other experiments with fowls, trials of homemade brooders and incubators, keeping eggs in dry packing, and caponizing.

(1) *Feeding fowls for the table.*—An experiment was made with 8 Capons and 8 Cockerels "to obtain data in regard to meat production." The fowls suffered from roup and "none of them regained vigor enough to show any returns for the food," although the feeding was continued for some months. The data obtained are tabulated.

(2) *Homemade brooders and incubators.*—Several forms tried at the station are briefly described and statements are made regarding chickens raised by these means.

While the chicks were fed very moderately and did not early attain heavy weights, the growth, although slow, was healthy and satisfactory for chicks confined in small yards. One lot of White Plymouth Rock chicks from the first hatch averaged 1.7 pounds at 12 weeks old. Some from later hatches averaged for different lots at 10 weeks old, White Plymouth Rocks 1.1 pounds; "Crosses" (four lots) 1.2 pounds, 1.1 pounds, 1.1 pounds, 1.2 pounds; Indian Games (two lots), 1.3 pounds, 1.2 pounds. Among the different lots of "Crosses," which were S. Wyandotte and Buff Cochin by B. B. R. Game, were included quite a number of Light Brahma chicks. Some Pekin ducks reared in this brooder averaged about 3 pounds at 10 weeks old and not quite 4 pounds at 12 weeks. The results of incubator and brooder work are intended for a bulletin when enough data to be instructive are obtained.

The temperatures of many hens observed in connection with the incubator experiments, are hardly consistent with the theory of "incubating fever" so often advanced. The temperature of hens not sitting varied in summer months from 103° F. to 109°, many being over 106°; and of sitting hens from 102.4° F. to 106.5°, the highest observed among those just beginning to sit being 108.6°.

(3) *Keeping eggs in dry packing.*

A few of the methods of packing eggs dry for keeping have been tried. With these the eggs were all wiped when fresh with a rag saturated with fat or oil in which had been mixed some antiseptic, and packed tightly in salt, bran, etc. Eggs packed during April and May in salt, and which had been wiped with cotton-seed oil to which had been added boracic acid, kept from 4 to 5 months with a loss of nearly one third, the quality of those saved not being good. Eggs packed in bran, after the same preliminary handling, were all spoiled after 4 months. Eggs packed in salt during March and April, after wiping with vaseline to which salicylic acid had been added, kept 4 and 5 months without loss; the quality after 4 months was much superior to ordinary limed eggs. These packed eggs were all kept in a barn cellar, the ordinary temperature of which varied from 60° to 70° F., and each box was turned once every 2 days. Little difference was observed in the keeping of the fertile or the infertile eggs, and no difference was noticeable in the keeping qualities of eggs from different fowls or from those on different rations.

(4) *Caponizing.*

During our experience in caponizing many "slips" have appeared among those birds which were oldest when the operation was performed. The most favorable age seems to be within a few weeks after the time when the sex can readily be distinguished, and with those caponized at that time very few slips have been observed. Some have been operated upon by means of the second incision from the left side, but so far little advantage has appeared in this method. None have been lost here this year from the operation, and if care is taken in the fasting of the fowls and in selecting a bright day, there is no need of the fatality that is so often reported.

Feeding experiments with pigs (pp. 141–161).—Accounts are given of the experiments reported in Bulletins Nos. 22 and 28 of the station (see Experiment Station Record, vol. II, pp. 282 and 735), and analyses of pig manure.

Sorghum (pp. 162–168).—Tabulated notes on 30 varieties, results of examination of sorghum juices, and analysis of one sample of sorghum seed. A trial of top-dressing one half of each row of sorghum with carbonate of lime (4,000 pounds per acre) indicated no advantage from liming in regard to yield of cane and time of maturity. The juices of the canes grown on limed soil (12 varieties) averaged 11.31 per cent of cane sugar, and those of canes of the same varieties and stage of maturity grown on unlimed soils, 10.28 per cent.

So far as a single experiment goes this result is in accord with the idea that an application of some form of lime is of value to the sorghum crop on soils that contain little lime or in which the magnesia exceeds the lime. Every sample of soil from the station farm that has been analyzed has contained less lime than magnesia, the average in all the top soils being 0.65 per cent of lime (CaO) and 1.21 per cent of magnesia (MgO).

Field experiment with oats (pp. 168, 169).—A brief report of an unsuccessful fertilizer test with oats on 21 twentieth-acre plats. "The whole field was badly affected by rust."

REPORT OF CHEMIST, L. L. VAN SLYKE, PH. D. (pp. 170–256).—The author entered upon his duties July 12, 1890, succeeding E. F. Ladd.

Data obtained in connection with the test of breeds of dairy cows (pp. 171–242).—These data include analyses of the feeding stuffs used, *e. g.*, hay (timothy, red clover, clover and timothy, Kentucky blue grass, barley, oat, oat and pea, etc.), oat and vetch forage, oat and pea forage, maize forage, alfalfa forage, sorghum forage, maize silage, beet roots, mixed roots, linseed meal, ground oats, wheat bran, wheat middlings, cotton-seed meal, corn meal, grain mixtures, sweet milk, and skim milk; a detailed record up to the last of November, 1890, for each cow of the yield of milk and milk constituents, the composition of the milk, composition of butter, creaming and churning data, and the percentage of fat recovered and lost in butter making. Many of these data are incorporated in Bulletin No. 34 of the station (see Experiment Station Record, vol. III, p. 311). A description is given of the methods used in creaming, churning, and sampling butter for analysis.

Analyses of fertilizers (pp. 242–253).—Analyses of 69 samples of commercial fertilizers.

Experiments with methods of creaming (pp. 254–256).—The general plan of a series of experiments commenced on this subject is discussed. The data are reserved for a future bulletin.

REPORT OF ACTING HORTICULTURIST, C. E. HUNN (pp. 257–308, plates 15).—The work of the year included tests of varieties of small fruits and vegetables; a comparison of imported *vs.* American-grown seed of cabbages and cauliflowers; a test of the relative yield of varieties of tomatoes grown by different methods of culture; a test of varieties of potatoes, in connection with which an experiment was made on the liability to decay of tubers taken from varieties subject to decay last year as compared with tubers of varieties that were free from decay; a continuation of experiments in cross-fertilization of fruits; and notes on insects and fungi and the means for their repression.

Strawberries (pp. 258–276).—Brief descriptive notes on 103 varieties grown at the station, with tabulated data regarding the prevalence of blight on these varieties in different years (1886–90), and descriptive notes on 43 varieties grown at Pulaski, New York, by L. J. Farmer, and on 11 varieties grown at Rochester, New York, by Green's Nursery Company. The results of experiments in crossing varieties are illustrated in 15 plates, accompanied by brief descriptive notes.

"Of 1,000 seedlings fruiting during the seasons of 1888 and 1889, but 20 were saved as showing any indication of being of value. Of these 20, 15 have been discarded this season. Of 700 seedlings fruiting this year for the first time, less than 50 have been noted as good enough to give 1 more year's trial."

As shown in the illustrations, many of the plants resulting from cross-fertilization in 1890 produced fruits quite unlike those of either of the parents.

"Every plant of Crescent, without regard to the pollen variety, had fruits of wide variation. Plants of Johnson Late fertilized with 3 different varieties show great resisting qualities, as every fruit is of the type of the female plant."

Raspberries, blackberries, currants, and gooseberries (pp. 276–285).—Brief descriptive notes on 45 varieties of raspberries, 15 of blackberries, and 9 of black currants, and a list of 13 varieties of gooseberries which fruited at the station in 1890.

Beans, corn, and celery (pp. 285–288).—Brief descriptive notes on 9 varieties of bush beans, 3 of pole beans, 7 of corn, and 5 of celery, with tabulated data for 15 varieties of beans.

Cabbages and cauliflowers (288–292).—Tabulated data for 10 varieties of cauliflowers and 18 of cabbages grown from seed produced in Germany, France, and England, on Long Island, and in the region of Puget Sound. The results obtained in 1890 agree with those of the previous year in indicating that the American-grown seed is in no way inferior to the imported seed.

Peas (p. 293).—Brief descriptive notes on 11 varieties.

Potatoes (pp. 293–295).—Unfavorable weather and the prevalence of rot so far interfered with the experiments with potatoes that no report on them is given except brief tabulated data for a test of the seed from healthy and decayed tubers.

Sweet potatoes (pp. 296, 297).—Nine varieties were grown in 1890, yielding tubers in paying quantities, as did those grown at the station in 1889. The product of that year kept well until after the middle of January. In 1890 the tubers appeared very wet at harvest, and some of them were dried in the kiln of a hophouse for 52 hours. A table gives the percentages of water evaporated from them.

Tomatoes (pp. 297–306).—Descriptive notes and tabulated data for 19 varieties grown in different ways.

In setting the plants each row was run east and west, then a wire trellis was run north and south, taking in the eastern plant of each variety. The next plant in each row was kept trimmed, allowing the sunlight to penetrate to the soil and reach every fruit. The three following plants were allowed to mat at will. The sixth plant was trained to a stake, and the extreme western plants were grown on a wire trellis. The trimmed plants in almost every case gave the first ripe fruits, but both west trellis and stake plants ripened 10 fruits as early as did the trimmed plants.

A test of tomatoes from seed from ripe *vs.* green fruit begun in 1883 was continued in 1890. The results agree with those of previous years.

The plants from immature seed ripened fruits 10 days in advance of those from mature seed. The growth of vines in 1890 was more vigorous than in previous years and the fruit larger. This was probably due to the fact that the specimen fruit selected for seed in 1889 was of large size, and while very green had nearly obtained its maximum development. It is evident that the immature seed give the earliest fruits, and also that such seed lack vitality to give a large per cent of germinations and a good growth of leafage, but it is yet a question of how much further towards a perfectly ripe fruit it will be best to go to procure seed that will give more vigor of plant and still retain the early-ripening qualities of immature seed.

Insects, insecticides, and fungicides (pp. 307, 308).—Brief notes on experiments in the treatment of the flea beetle, currant worm, potato beetle, gooseberry mildew, and the disease of the hollyhock (*Puccinia malvaccarum*). The combination of hellebore for the currant worm and potassium sulphide for the gooseberry mildew did not prove satisfactory as far as checking the mildew was concerned, though the fungicide alone gave good results. Dipping tomato plants in a solution of Paris green at time of planting largely prevented the ravages of the potato beetle. The plant protector, tested in 1889, was used again in 1890 with satisfactory results.

REPORT OF ACTING POMOLOGIST, G. W. CHURCHILL (pp. 309–351).—In 1890 there was a general failure of the fruit crop in western New York, except in the case of grapes and strawberries. The failure of the apple crop was especially discouraging, as this was a year when an abundant yield was expected. Causes of this failure are briefly discussed in this report.

Grapes (pp. 310–332).—In recent years much attention has been given to the culture of grapes in New York, but many farmers have not taken sufficient pains to plant varieties adapted to the peculiarities of local soils and climates, so that much inferior fruit has been put upon the market. The profits of the business have thus been greatly reduced. Certain diseases of the grape have also been very troublesome. The report contains extracts from correspondence showing the benefits of spraying vineyards with fungicides. The following diseases of the grape are described and suggestions are given for their treatment: Black rot (*Physalospora bidwellii*), downy mildew (*Peronospora viticola*), anthracnose (*Sphaceloma ampelinum*), powdery mildew (*Uncinula spiralis*), grape leaf blight (*Cercospora viticola*), white rot, and bitter rot. There are also descriptive notes on 17 varieties of black grapes, 15 of red grapes, and 13 of white grapes.

Peaches (pp. 332–334).—Thus far no variety of peach has been found that can be relied upon to produce a crop with sufficient regularity to make orchards remunerative in the region of the station. The author urges the necessity of experiments in cross-fertilization and selection of seed with a view to producing a variety suitable for this section. The station hopes to undertake work in this direction before long.

Some common fungous diseases and their treatment (pp. 334–339).—Notes on treatment of the diseases of grapes mentioned above, and on apple and pear scab (*Fusicladium dendriticum* and *F. pyrinum*), and the black knot of the plum and cherry.

Insects and remedies (pp. 339–345).—Brief notes on insects injurious to the trees and fruit of the apple, plum, and peach.

List of varieties of fruits (pp. 346, 347).—This includes 43 varieties of apples (14 Russian), 1 of crab apples, 20 of pears, 15 of plums (2 Russian, 1 Japanese, and 2 American), 11 of peaches, 1 of cherries (Russian), and 1 of grapes, planted in 1890. The varieties planted in previous

years were catalogued in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 599).

Station arboretum (pp. 347–351).—A list of 108 species and varieties of deciduous trees and 19 of evergreen trees.

REPORT OF FARM SUPERINTENDENT, F. E. EMERY (pp. 352–471).—The following topics are treated: Grasses and forage crops; peas best for forage; raising scrub stock; comparison of roots and silage; variety tests of wheat; potato experiments, 1890; after effects of fertilizers, 1889; report on lysimeters for 1889; rations of dairy animals; meteorology for 1890.

Grasses and forage crops (pp. 353–356).—Notes in continuation of those in the Annual Reports of the station for 1888 and 1889 (see Experiment Station Bulletin No. 2, part I, p. 164, and Experiment Station Record, vol. II, p. 594). Tabulated data are given for the yields in 1890 of mixtures of forage plants seeded on large plats in 1886.

Peas for forage (pp. 357, 358).—A brief account of a test of 4 varieties. The Canada pea gave the largest yield.

Flax growing (pp. 358, 359).—A brief account of a test of 4 varieties from seed grown in California.

Raising scrub stock (pp. 359–364).—Data including gain in weight and cost of food are tabulated for four calves from native cows, which were raised to determine the cost of growth for beef. They were all sold for beef, their ages at the time of sale varying from 8 to 13 months. "At the prices given for food these animals were raised at a considerable loss when offered in the common market."

Roots vs. silage for cows (pp. 364–368).—The results are briefly tabulated for a trial with two Jersey cows fed mangel-wurzels and silage alternately for four periods of about 10 days each. Hay and a grain mixture composed of oats, linseed meal, and wheat middlings were fed with each ration. The results were favorable, financially and otherwise, to the silage.

Test of varieties of wheat (pp. 369–372).—Notes and tabulated data for 5 varieties of winter wheat and 14 of spring wheat. Fulcaster and New Light Amber among the winter varieties and Kubanka, Petali, Saskatchewan, Pure Scotch Fife, and Palestine among the spring varieties gave the largest yields.

Potato experiments (pp. 372–389).—These included experiments with different amounts and kinds of seed, methods of cultivation, and fertilizers. An account of the experiments of the previous year may be found in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 595).

(1) *Whole tubers of different sizes for seed.*—In an experiment in which tubers of three different sizes were planted, the largest yield was obtained from the largest tubers.

(2) *Whole tubers vs. cuttings.*—In this experiment the following yields in bushels per acre were obtained: Whole tubers (planted at the rate

of 33 bushels per acre) 125.9, halves (22.5 bushels) 100, quarters (15 bushels) 82.45.

(3) *Experiment with different kinds of fertilizers.*—Dissolved bone-black, muriate and sulphate of potash, sulphate of ammonia, and nitrate of soda, in different combinations, were applied in 1890 on 10 plats. The results, as tabulated, agree in general with those of the previous year. Muriate of potash was more effective than sulphate of potash. The increase of yield due to nitrate of soda or sulphate of ammonia was too small to make it profitable to use either of these fertilizers.

(4) *Change of seed.*—The results of an experiment in which seed of the White Star variety, grown at the station and in two other localities in New York, were planted, were inconclusive.

(5) *Flat culture vs. plowing up to the rows.*—In an experiment undertaken late in the season the largest yields were obtained from flat culture. The plants in the rows plowed up to made a more vigorous growth of vines.

After effect of fertilizers on corn (pp. 389, 390).—The yields of corn are given for 13 twentieth-acre plats which had been used in fertilizer experiments on grass.

Lysimeter record for 1889 (pp. 390–401).—Notes and tabulated data on observations on the old and new lysimeters at the station. The peculiarities in the construction of the new lysimeters were described in the Annual Report of the station for 1888 (see Experiment Station Bulletin No. 2, part I, p. 151).

Rations of dairy animals (pp. 401–444).—Tables are given showing the quantity and chemical composition of the various foods eaten by each of the cows included in the test of dairy breeds referred to above, from April to September, 1890.

Meteorology for 1890 (pp. 445–471).—Tabulated details of observations of the temperature of the air, rainfall, direction of the wind, amount of sunshine, and soil temperatures at the surface and at depths of from 1 to 18 inches. The yearly summary is as follows: *Air temperature* (degrees F.).—Maximum, 96.2; minimum, 2; mean, 48.05. *Precipitation.*—Total (inches), 36.88; number of days on which precipitation was appreciable, 134. *Wind.*—Prevailing direction, W to SW. *Sunshine* (per cent of possible).—Maximum, 61.4 (during July); minimum, 12.1 (during December); mean, 33.6.

New York Cornell Station, Bulletin No. 32, October, 1891 (pp. 49).

NOTES ON TOMATOES IN 1891, L. H. BAILEY, M. S., AND E. G. LODEMANN, B. S. (pp. 143–178, figs. 3).—This is an account of experiments in a number of different lines. Previous reports of investigations on tomatoes may be found in Bulletins Nos. 10, 21, and 28 of the station (see Experiment Station Record, vol. I, p. 276, vol. II, p. 366, and vol. III, p. 91).

Studies of fertilizers (pp. 143–149).—Experiments in the field and forcing house during 3 years have uniformly shown that liberal manuring increases the yield of tomatoes. In order to determine whether the late application of fertilizers tends to decrease productiveness before frost, an experiment was made in 1891 on 34 plats of light, gravelly loam. Each plat contained about one fifty-fourth of an acre, and received 10 pounds of nitrate of soda (at the rate of 540 pounds per acre). On 17 plats the fertilizer was all applied at one time—June 25, 15 days after the plants were set in the field. On the other 17 plats the fertilizer was applied at intervals, as follows: 2 pounds June 25, 2 pounds July 13, 3 pounds August 3, 3 pounds August 28. Three plants of the Ignotum variety were grown on each plat. "The results of the experiment are presented in two tables, the former showing the yields previous to the last picking and the latter including the last picking (October 5)."

Yields of tomatoes with different methods of applying fertilizers.

	Lot I, one application (10 pounds).			Lot II, four applications (10 pounds).		
	Average number of fruits per plant.	Average weight of crop per plant.	Average weight of individual fruits.	Average number of fruits per plant.	Average weight of crop per plant.	Average weight of individual fruits.
		Pounds.	*Ounces.*		*Pounds.*	*Ounces.*
Crop previous to last picking.	14.2	5.5	5.7	13.2	4.6	5.6
Total crop	23.0	7.5	5.4	24.5	8.1	5.4

These results indicate that up to the last picking the single application of the fertilizer gave the best yields, but that the effect of the intermittent application of the fertilizer was to increase the yield at the last picking so materially that the entire season's crop favored this method of application.

Frost held off until the second week of October, so that it happened that the intermittent fertilizing gave us the better result, but had frost come the last of September, as it frequently does at Ithaca, it would have given us the poorer result. It is therefore not advisable to apply nitrate of soda to tomatoes in this climate so late as the latter part of August. On the other hand, the tables show that the nitrate gives better results when applied two or three times than when the same amount is applied at once.

Reference is made to somewhat similar experiments reported in Bulletin No. 79 of the New Jersey Stations (see Experiment Station Record, vol. III, p. 30), in which it was found that two applications of nitrate of soda on the crop maturing in July and August increased the yield without delaying maturity, while one heavy early application increased the yield at the expense of maturity.

In another experiment on 7 fortieth-acre plats of stony clay loam of poor quality, nitrate of soda, boneblack, and muriate of potash were applied singly, two by two, and all three together on Ignotum tomatoes set in the field June 12. The results, as tabulated, indicate that in single

treatments nitrate of soda gave the poorest and muriate of potash the best results. In the double combinations the best results were with nitrate of soda and boneblack. The highest yield was, however, obtained when all three of the fertilizers were used together. These results, taken in connection with those obtained in 1890, show that nitrate of soda should not be used alone for tomatoes on poor soil.

To see whether highly improved varieties of tomatoes would respond more readily to the application of fertilizers than small and unimproved varieties, two dozen plants of Ignotum, Ithaca, and the plum tomato (Golden Fig) were set out on poor, hard clay loam. Half of the plants received a single application of a "complete fertilizer" and the other half were not manured. The tabulated results show that in the improved varieties increase in the number of fruits was accompanied by a decrease in the weight of individual fruits. In the unimproved variety there was less increase in number and no loss in size of fruits, so that there was a greater proportionate gain in the weight of the crop.

Early and late setting (pp. 149, 150).—Plants set in the field May 9, 1891, gave larger yields than those set June 10, despite the fact that dry and cold weather followed the earlier planting. This agrees with the results of a similar experiment in 1890.

Few and many transplantings (pp. 150, 151).—Two series of experiments were made. In one the plants were set in the field May 9 and in the other June 10. In both cases a comparison was made of transplanting once, twice, and three times. The tabulated results show that two transplantings gave the largest yields, though in one instance three transplantings gave the earliest fruits.

Seeds vs. cuttings (pp. 151, 152).—In 1890 seedling plants were much more productive than cuttings. In 1891 Lorillard plants gave a much better crop from seedlings, but in the case of very poor plants of the Ithaca variety the results were reversed. The cuttings in both lots gave earlier fruits than the seedlings. In a single experiment where cuttings were taken from cuttings of the Lorillard variety the first fruits were obtained quite late, but the yield and size of the fruit were much greater than in the case of the parent plants. The second cuttings made short, stocky plants with numerous branches, while the first cuttings made a tall growth.

Trimming (pp. 152–154).—Experiments in 1890 in trimming plants twice (July 18 and August 25) gave increased earliness and productiveness. Similar experiments were tried in 1891 on some 40 plants of 7 varieties. Three trimmings (August 3 and 24, and September 18) were made. The results, as tabulated, show that there was increase in earliness only in one case and gain in productiveness only in two instances. In two cases there was a decided loss. "It is therefore evident that if trimming is to be done at all it must be performed rather early."

Single-stem training (pp. 154–156).—"In the account of forcing tomatoes, given in Bulletin No. 28 of the station [see Experiment Station Record, vol. III, p. 91], it was stated that the yield was about 2 pounds per square foot of floor space, which is over three times the yield of a good crop of outdoor tomatoes." To determine whether the house system of training is practicable for field culture several experiments were made.

We used in one experiment stakes 1½ by 1½ inches and 5 feet high, driven securely into the ground. In another we drove stakes in lightly and held them in place by two wires drawn in between them in an alternating fashion near their tops, the wires being held by posts set every 16 feet. This made a wire and picket fence, except that the lower ends of the pickets were held in the ground. This is the cheapest and best trellis which we tried. * * *

We also used perpendicular strings stretched between two horizontal wires, one near the ground and the other 5 feet high, and also one or two other trellises, but they were not so good as stakes supported by wire. The plant was tied loosely to the support, at intervals of a foot or so, as it grew, and all side shoots were pinched out as fast as they appeared. In this way only one stem was allowed to grow. The plants were set a foot apart in the row, and the rows were 3 feet apart. Several varieties were tried, but only the average results are given. * * *

Two series of trellises were erected, and the same number of plants was set in an ordinary patch alongside each one. * * *

The trellis plants gave 1.6 pounds of ripe fruit to each square foot, while the other plants gave 0.75 pound, or less than half as much. It is to be noted also that the former gave earlier results. We also found that rot was much less upon the trellis plants than upon the others.

It is doubtful if this single-stem training can be profitably used for the main field crops, but for early market or choice trade and for home use it appears to possess decided advantages.

Hilling (p. 156).—An experiment with Ignotum plants on poor clay loam showed no advantage from hilling as regards either earliness or productiveness.

"Leggy" plants (pp. 156, 157).—Burying the stems of badly drawn plants in a horizontal position so as to leave only 10 or 12 inches of the stem erect, increased earliness, number of fruits per plant, and weight of crop. Normal plants, however, gave much better results than "leggy" plants, even when the latter were set deep.

Products of early and late fruits (pp. 157–159).—The results are tabulated of an experiment in which seeds of 8 varieties from fruits picked August 5 and September 17, were compared. The averages for the seeds of the respective dates were as follows: Number of fruits per plant 30.7 and 36.9, weight of fruits per plant 7.5 and 9.4 pounds, weight of individual fruits 4.1 and 4.6 ounces. In earliness there was no constant difference. Reference is made to experiments reported in Bulletin No. 48 of the Michigan Station (see Experiment Station Record, vol. I, p. 89) in which the early angular varieties gave better results from seed from first fruits, while the reverse was true of the round or apple-shaped varieties. The experiments thus far do not warrant definite conclusions, but "little if anything appears to be gained by selecting seeds from first

ripe fruits with no reference to the character of the plant from which they come."

Fruit rot (pp. 159, 160).—Facts from the experience of the author are cited which indicate that vigorous plants, early setting, and especially upright and open training will diminish the amount of rot.

Keeping qualities of tomatoes (pp. 161–164).—The tabulated results of keeping tests of a number of varieties in 1889 in the sunlight in a forcing house, and in 1891 in a cool, dry room, without sunlight, agree in indicating that the small and comparatively unimportant varieties will keep the longest; but that in general keeping quality is not connected with solidity or varietal differences.

Do fertilizers modify quality? (pp. 164, 165).—Chemical analyses of tomatoes grown in the fertilizer experiments above referred to gave the following results:

Fertilizers.	Solids.	Sugar.	Malic acid.
	Per cent.	*Per cent.*	*Per cent.*
(1) Stable manure on sandy loam	4.92	3.89	0.80
(2) Nitrate of soda on clay loam	6.02	5.12	0.76
(3) Muriate of potash	5.97	4.97	0.68
(4) Nitrate of soda and boneblack	6.00	5.07	0.70
(5) Nitrate of soda and muriate of potash	5.93	4.92	0.68
(6) Boneblack and muriate of potash	5.90	5.08	0.71
(7) Boneblack and muriate of potash	5.86	4.89	0.71
(8) Nitrate of soda, boneblack, and muriate potash	6.04	5.01	0.77

Crosses (pp. 165–168).—In the winter of 1890–91 a few successful hybridizations were made between the Ithaca (*Lycopersicum esculentum*) and Currant (*L. pimpinellifolium*) tomatoes. The parents and hybrids are described and illustrated. Brief accounts are also given of crosses made between red and yellow varieties and between purple and red varieties.

The hybrid between Ithaca and Currant was intermediate between the parents, and produced fruits four times the size of the Currant in clusters of from 6 to 14.

Crosses between yellow and red tomatoes, the yellow being the pistillate or seed parent, uniformly gave red fruits; and crosses between purple and red varieties also gave red fruits.

Crosses between the large leaf and common type of tomatoes (Mikado and Ignotum) gave foliage of a peculiar type intermediate between the two. This peculiar foliage is also a characteristic of Ruby Queen.

Do tomatoes mix in the field? (pp. 68–171).—"Two or three plants of each of 6 varieties were set closely together in a row, all the plants of each variety being together. The varieties and the order were as follows: (1) Potato Leaf, (2) German Raisin, (3) Golden Queen, (4) Favorite, (5) Jaune Grosse Lisse, (6) Mansfield Tree. * * * Several fruits were saved from each variety and a few plants were grown from them." A record of the results is given. These indicate that "tomatoes mix in the field, and even hybrids with the Currant type of tomato may arise spontaneously. Red tomatoes sometimes come from yellow and purple fruits. It is therefore evident that seeds should be selected from plants which are somewhat removed from other varieties."

Do varieties of tomatoes run out? (pp. 171–173).—"Studies of this question were made in 1891 by growing the same varieties from many seedsmen. * * * In order to determine how long a variety may persist we selected Grant and Canada Victor, which are old varieties; and to find out how soon a variety may depart from its type we grew the Ignotum." The results, as stated, confirm the previously expressed views of the author, that varieties of tomatoes lose their distinguishing characters. In the case of seeds of Ignotum from fifteen different dealers, 8 samples gave small and poor fruits, which could not be recognized as belonging to that variety. "It is not certain that all this variation is chargeable to running out of the variety."

Impressions of varieties (pp. 173–176).—Brief descriptive notes are given on 17 varieties. Ignotum is especially commended. Among new varieties the following are the most promising: Cumberland Red, Long Keeper, Mitchell, Potomac, Red Mikado, and Stone.

SUMMARY OF STUDIES ON TOMATOES, 1886–91, L. H. BAILEY, M. S. (pp. 179–189).—Most of the conclusions stated in this summary have been recorded in Bulletins Nos. 10, 21, and 28 of the station (see Experiment Station Record, vol. I, p. 276; vol. II, p. 366; and vol. III, p. 91). For accounts of the earlier work of the author on tomatoes see Bulletins Nos. 19 and 31 of the Michigan College and Station (permanently bound in the Reports of the Michigan State Board of Agriculture for 1886 and 1887).

The classification of varieties adopted by the author is as follows:

1. *Lycopersicum pimpinellifolium* ...	Currant and German Raisin, not yet varied to any extent in cultivation.
2. *Lycopersicum esculentum*	(1) Var. *cerasiforme* (cherry varieties). (2) Var. *pyriforme* (pear and plum varieties). (3) Var. *vulgare*. { *a*. Oblong varieties. *b*. Angular varieties. *c*. Apple-shaped varieties. } (4) Var. *grandifolium* (large leaf varieties). (5) Var. *validum* (upright plant).

If the Cherry tomato is taken as the starting point of the cultivated tomatoes, the evolution may be expressed as follows:

Cherry	Pear-shaped sorts.—Oblong sorts. Orangefield or similar kinds.—Angular sorts. Green Gage, Large Yellow, White Apple, etc.—Yellow apple-shaped sorts. Little Gem, The Cook's Favorite, or similar kinds.—Large red sorts.—Grandifolium. Validum.

There is much direct evidence to support this genesis of the tomato. The most doubtful point is whether the pear tomato has come from the cherry or is aboriginal with it. For a discussion of the reasons for this tabulation, drawn from morphology, see an illustrated article in the *American Naturalist*, June, 1887, p. 573.

North Carolina Station, Bulletins Nos. 80*b* and 80*d* (Meteorological Bulletins Nos. 23 and 24), September 15 and October 15, 1891 (pp. 17 and 16).

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, AUGUST AND SEPTEMBER, 1891, H. B. BATTLE, PH. D., AND C. F. VON HERRMANN.—Notes on the weather, monthly summaries, and tabulated daily records of meteorological observations by the North Carolina weather service, coöperating with the U. S. Weather Bureau. The bulletins are illustrated with maps of North Carolina showing the isothermal lines and the total precipitation at the stations in different parts of the State.

Ohio Station, Bulletin Vol. IV, No. 6 (Second Series), October, 1891 (pp. 19).

EXPERIMENTS WITH SMALL FRUITS IN 1891, W. J. GREEN (pp. 115–123, plates 2).—This includes brief descriptive notes on 19 of the newer varieties of strawberries, 7 of raspberries, and 8 of blackberries, and an account of spraying experiments in the treatment of raspberry anthracnose. The following summary is taken from the bulletin:

Strawberries.—The blossoms of perfect-flowered varieties of strawberries are more easily killed by frost than those having imperfect flowers. Haverland, Crescent, Warfield, and Bubach are the most reliable of the fully tested varieties of strawberries. Gandy, Pearl, and Miner are suitable for pollenizers. The most promising new varieties are Brunette, Barton Eclipse, Beder Wood, Dayton, Enhance, Greenville, Ivanhoe, Lovett Early, Muskingum, Parker Earle, and Shuster Gem. The following require further trial, but so far seem to be worthy: Bessie, Edgar Queen, and Van Deman. The following appear to have but little value, or at least some serious faults: Stevens, Great Pacific, Lady Rusk.

Raspberries.—The following varieties are recommended for general cultivation: Gregg, Ohio, Hilborn, Palmer, Turner, Cuthbert, Brandywine, and Shaffer. The following new varieties are promising: Cromwell, Kansas, Lovett, Muskingum, Royal Church, Thompson Early Prolific. Smith Prolific appears to be of little value because of its tendency to rust.

Blackberries.—The hardiest varieties and most suitable for this latitude are Snyder, Ancient Briton, and Agawam. Erie and Minnewaski are the most promising new varieties. The value of Early Harvest seems to have been overlooked. It is very early and comparatively hardy. Wilson Jr. and Child's "Everbearing Tree Blackberry" are too tender for this latitude. The latter name is a misnomer, and the variety is the most nearly worthless of any that have been tested here.

Raspberry anthracnose.—The following fungicide has proved efficient: Copper sulphate 4 pounds, lime 4 pounds, water 50 gallons. Four applications should be made during the season, the first before growth has commenced in the spring and the last just before the time of blooming. Care should be taken in making the second, third, and fourth sprayings to direct the spray toward the young canes, and to keep it off the leaves of the bearing canes. Six ounces of copper carbonate dissolved in 3 pints of ammonia and diluted with water to 50 gallons is nearly as efficient as the above, but preference is given to the diluted Bordeaux mixture.

DISEASES OF THE RASPBERRY AND BLACKBERRY, F. DETMERS, B. S. (pp. 124–131, plates 2).—A description of anthracnose of the raspberry and blackberry (*Glœosporium venetum*), *Septoria rubi*, red rust (*Cœoma nitens*), and a bacterial disease of the raspberry.

Ohio Station, Bulletin Vol. IV, No. 7 (Second Series), November, 1891 (pp. 28).

HESSIAN FLY, F. M. WEBSTER (pp. 133–158, figs. 8).—The different stages of *Cecidomyia destructor* are described and illustrated. A brief account is given of the earlier investigations of this insect in this country, and a report of the author's observations in Indiana on the number and development of the broods, effect of the larvæ on plants, and the effect of the weather on the development of the fall brood, together with a résumé of preventive measures, taken from an article by the author in Bulletin No. 23 of the Division of Entomology of this Department (see Experiment Station Record, vol. III, p. 55).

Oregon Station, Bulletin No. 12, September, 1891 (pp. 9).

STRAWBERRIES, G. COOTE (pp. 3–8).—Notes and tabulated data for 27 varieties tested in 1891. The following are recommended: *Early.*—Michel Early, Warfield, and Jessie; *medium.*—Bomba, Hampden, Glendale, and Van Deman; *late.*—Dutter, Cumberland, and Gandy. Each variety was grown in hills and in matted rows. With a few exceptions the largest yields were obtained from the matted rows.

METEOROLOGICAL SUMMARY, MARCH–JULY, 1891, J. FULTON, B. S. A. (p. 9).—A tabulated monthly summary of meteorological observations and of soil temperatures at depths of from 2 to 48 inches, taken at the State Agricultural College.

Oregon Station, Bulletin No. 13, October, 1891 (pp. 8).

MISCELLANEOUS ANALYSES AND SOIL INVESTIGATIONS, G. W. SHAW, M. A.—Tabulated analyses of gypsum, mineral water, and a saline deposit from mineral water. The station intends to make studies of soils preliminary to an agricultural survey of the State, and for this purpose desires to collect samples of soils from different localities. Directions are given for taking soil samples.

Utah Station, Bulletin No. 8, August, 1891 (pp. 16).

SILAGE, J. W. SANBORN, B. S.—A description is given of the station silo, the method of filling the silo, and of two feeding experiments with silage *vs.* fodder corn, one with steers and the other with sheep. The silage and fodder corn used were from "nearly ripe" material cut August 27; "the leaves and husks were then turning yellow." The feeding trial included 6 steers, averaging about 720 pounds each in weight, and 6 sheep. The steers and sheep were each divided into two equal lots, one lot receiving silage and the other dried fodder corn throughout the trial (about 2½ months). Both lots received the same amount of a grain mixture, composed of wheat bran, oats, and ground wheat. Neither the steers nor the sheep ate the silage readily. During the feeding the 3

steers fed silage lost 14 pounds, and the 3 fed dry fodder corn gained 6 pounds; the sheep fed silage gained 26 pounds, and those fed fodder corn gained 30 pounds. The tabulated results include the weight of each lot at beginning and close of the trial, the food and dry matter eaten, and analyses of the carcasses of 2 steers from each lot. The conclusions drawn by the author are unfavorable to the silage system in Utah.

Wyoming Station, Bulletin No. 3, November, 1891 (pp. 32).

The sugar beet in Wyoming, D. McLaren, M. S., and E. E. Slosson, B. S. (pp. 35–63).—Information is given regarding the world's supply of sugar; the climate and soil desirable for the sugar beet; and the cultivation, irrigation, harvesting, storing, and cost of raising the beet. The results of analyses of 70 samples of beets grown at the six experiment farms of the station in different parts of Wyoming in 1891 are given. The analyses were made either by the station, the Utah Sugar Company, or this Department. The bulletin also contains directions for reporting the results of coöperative experiments to be made by farmers in Wyoming in 1892 with sugar beet seed distributed by the station. The average per cent of sugar found in the analyses reported was 15.79, with a maximum of over 22 per cent; the average purity was 78.08. The presence of "alkali" in the soil did not reduce the percentage of sugar. The experiments seem to indicate that the climate and soil of Wyoming are well adapted to the sugar beet, and that the use of irrigation enables the farmer to so control the moisture in the soil as to secure a relatively large sugar content.

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF STATISTICS.

REPORT NO. 90 (NEW SERIES), NOVEMBER, 1891 (pp. 593–634).—This includes a report on the estimated yield per acre of corn, potatoes, cotton, buckwheat, hay, and tobacco; notes from reports of State agents; European crop report for November; an article on agriculture in Paraguay, South America; notes on foreign agriculture; and rates of transportation companies.

DIVISION OF ENTOMOLOGY.

INSECT LIFE, VOL. IV, NOS. 3 AND 4, NOVEMBER, 1891 (pp. 87–162, figs. 11).—The principal articles in this double number are: The Larger Cornstalk borer (*Diatræa saccharalis*), by L. O. Howard; On the Habits and Life History of *Diabrotica 12-punctata*, by C. V. Riley; A New Herbarium Pest (*Carphoxera ptelearia* n. gen. and sp.), by C. V. Riley; *Ugimyia sericariæ*, the Parasite of the Japanese Silkworm, by J. Mik; Further Notes on *Panchlora*, by C. V. Riley; Some Studies of the Clover Hay Worm (*Asopia costalis*), by F. M. Webster: Some of the Bred Parasitic Hymenoptera in the National Collection (continued); The Three Pear Tree Psyllas (*Psylla pyrisuga*, *P. pyri*, and *P. pyricola*); The First Introduction of *Blastophaga psenes* into California, by G. Eisen; Comments on the Fifth Report of the U. S. Entomological Commission, by J. Hamilton.

In the article on the larger cornstalk borer a bibliographical history of the insect is given, together with an account of its life history and habits, illustrated by three figures. In the summer of 1891 the borer was observed to feed on the stalks of gama grass (*Tripsacum dactyloides*), thus adding another species to the list of its food plants. For the past three quarters of a century this insect has been recognized as a serious enemy of sugar cane in the West Indies, and for over 30 years has infested cane and corn in the Southern States. It has been particularly abundant in the cornfields of Louisiana, where it was first recorded in 1857. It has slowly spread throughout the cotton States, and in 1891 seriously injured corn in Virginia and Maryland. "Where

the old stalks are systematically removed from the field and burned after harvest or during winter, or where a constant rotation of crops is practiced, the cornstalk borer will never become a serious pest."

Besides an account of the life history and habits of *Diabrotica 12-punctata*, the facts relating to the ravages which the larvæ of the insect have in recent years been observed to make on young corn, are stated. The different stages of the insect are illustrated, as well as a cornstalk showing punctures made by larvæ.

Experiments in breeding cages indicated that the eggs of the clover hay worm "may be deposited on the plants in the field, and thus the larvæ be drawn to the stack or mow, and also the eggs may be deposited in the stacks in the field early in August."

BULLETIN NO. 6 (SECOND EDITION).

THE IMPORTED ELM LEAF BEETLE, C. V. RILEY (pp. 21, plate 1, fig. 1).—A reprint of a bulletin on *Galeruca xanthomelæna*, issued in 1885, with an appendix stating some additional facts. The observations of the past 6 years tend to modify previous conclusions regarding the number of annual broods. In New Jersey it has recently been claimed that there is but one annual generation, but in the vicinity of Washington, D. C., it is safe to say that there are two broods. Reference is made to a record of spraying experiments by J. B. Smith in *Garden and Forest*, June 19, 1889. In these experiments a small quantity of kerosene emulsion was added to the arsenical mixture to secure thorough wetting of the leaves. The formula recommended by him was: Water 100 gallons, London purple 1 pound, kerosene emulsion 1 gallon. Dilution with 150 or even 200 gallons of water would make a safer and sufficiently effective mixture.

DIVISION OF BOTANY.

BULLETIN NO. 14.

ILEX CASSINE, THE ABORIGINAL NORTH AMERICAN TEA, E. M. HALE (pp. 22, plate 1).—An account of the botany, chemistry, distribution, history, and uses of *Ilex cassine*, a species of holly "growing in the Southern States along the seacoast, not extending inland more than 20 or 30 miles, from Virginia to the Rio Grande. Its leaves and tender branches were once used by the aboriginal tribes of the United States in the same manner as the Chinese use tea and the South Americans use maté. But while the use of *Thea sinensis* and *Ilex paraguayensis* still survives, the use of the shrub above mentioned has been almost abandoned by our native Indians and by the white people who once partially adopted it as a beverage."

In 1884 F. P. Venable, Ph. D., of the University of North Carolina, detected the presence of the caffeine in the leaves. Somewhat later he

analyzed the dried leaves with the following result: Water in air-dried samples 13.19, extracted by water 26.55, tannin 7.39, caffeine 0.27, nitrogen (on combustion) 0.73, ash 5.75 per cent. In 1885–86 no alkaloid was found by analysis of the leaves and berries of *Ilex opaca*, *I. dahoon*, and *I. cassine*, except caffeine in the leaves of the last-named species.

Further investigation is needed to show whether this plant can be utilized in any way.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

The distribution of starch in trees during winter, E. Mer (*Compt. rend., 1891, pp. 964–967; Centralbl. f. agr. Chem., 20, 1891, pp. 515–517*).—The author studied the distribution of starch in different kinds of trees during the months from October to April, and found it to be far from constant during this time. In the middle of October he found starch abundant in the bark as well as the bast and xylem. A month later it had nearly all disappeared from the bark and bast of the branches and upper part of the tree; and the amount in the xylem, while differing with the kind of tree, was in all cases less than in summer. The resorption of starch went on steadily for a month or two, when it was nearly completed. This condition remained without change until early in March, when the starch granules first appeared in the green bark of the branches, then in the bast, and subsequently in the xylem of the upper portion of the tree. It appeared later in the bast and xylem of the middle portion of the tree, and last of all in the roots. By the end of April, before the buds had commenced to develop, apparently about the same quantity of starch had been stored up in the tissues of the plant as had been there the September previous.

This resorption of starch seems to the author to depend on the respiration in the xylem tissue, commencing at the time the leaves begin to lose their power of assimilation and continuing up to the beginning of the dormant stage of winter. In support of this theory he cites the following results of experiments with different kinds of woody plants:

(1) In beach trees from which the branches and roots had been removed in August, the starch had fully disappeared by October. Branches of fir from which the leaves had been removed, when kept in a room, lost in 2 months the entire amount of starch which they had previously contained.

(2) Oak, beach, fir, and pine trees were girdled in June some 25 feet above ground. The starch rapidly disappeared from all the tissues in that part of the tree below the girdle, the degree of rapidity of this disappearance varying with the different trees.

(3) Young oak and beach branches freed from all leaves and buds, when kept in water away from the light, lost their starch in one case after 2 and in others after 3 months.

As long as the tissue contains a certain quantity of water, he says the plant retains its activity, and it may happen that the reserve starch is completely resorbed after the dormant state has set in. Even after the falling of the leaves woody plants vegetate and respire for a time. These signs of life seem to be strongest in the bast.

It is believed that these investigations call attention to two processes in the growth of woody plants, which have long remained unobserved. The first of these is the resorption of starch in autumn, and the second the re-formation of the same in the spring—processes occupying from 6 to 8 weeks each. It would seem from this that the amount of starch stored in reserve in woody plants instead of being largest in winter is in fact least.

To what extent can free atmospheric nitrogen be utilized for the nourishment of plants? B. Frank (*Deut. landw. Presse, 1891, p. 779*).—The author reports pot experiments, made with yellow lupine and peas, which lead him to believe that bacteria are not essential in all cases to the assimilation of atmospheric nitrogen. His results indicate that both lupine and peas, when grown in sterilized soils containing humus, secured considerable quantities of nitrogen from some source, since the crop harvested contained several times the amount furnished by the seed, and the soils were found to contain somewhat more nitrogen at the close than at the beginning of the experiment. The symbiosis was, however, of advantage to the plants, especially to the peas, or to the lupines grown in light soil deficient in nitrogen, enabling them to secure more nitrogen. Thus, while the nitrogen in the pea crop was 13.1 times that in the seed when the plants were kept sterile, it was 26.5 times that in the seed when they were inoculated; and in the case of lupines grown in poor soil, while the nitrogen in the crop was 2.7 times that in the seed when the plants were kept sterile, it was 18.5 times that in the seed when the symbiosis was allowed. Lupine plants grown in soil to which humus was added contained, when kept sterile, 9.5 times and when inoculated 11.3 times as much nitrogen as had been supplied in the seeds. In all of the above cases the soil in the pots was slightly richer in nitrogen at the end than at the beginning of the experiment. It will be noticed that in these experiments the yellow lupine plants acquired considerably more nitrogen when grown in the poor soil than when grown in the richer humus soil, and that they were more benefited by the symbiosis in the former than in the latter case. In other experiments there was no perceptible advantage from manuring inoculated yellow lupine plants with ammonium sulphate or calcium nitrate, and in fact these plants contained a smaller quantity of nitrogen when manured than when grown in nitrogen-free soil. The inoculated pea plants, on the contrary, were benefited by the manuring, especially with calcium nitrate. The author infers from these results that the yellow lupine is eminently adapted to green manuring on light soils deficient in nitrogen, and that for this purpose the land

need only be manured with phosphoric acid and potash manures. Trials with oats, buckwheat, spurry (*Spergula arvensis*), and rape seemed to indicate that these plants also fix nitrogen. The plants were grown in glass jars filled either with sandy or loam soil, to which potash, phosphoric acid, and lime were liberally applied. The percentages of nitrogen in the soil before and after the experiment and in the seed and harvested crop were determined. These figures as given show that the nitrogen contained in the oat crop was 34.3 times, that in the buckwheat crop 11.6 times, that in the spurry 9 times, and that in the rape crop 114.2 times that supplied in the seed. The percentage of nitrogen contained in the soil at the end of the experiment was in every case slightly in excess of that contained before the experiment, indicating that the soil had not been depleted in nitrogen by the cropping. The author assumes that the nitrogen acquired by the plants was derived from the atmosphere, and without the aid of symbiosis with lower organisms.

A new reagent for albumen, J. S. MacWilliam (*Rev. intern. des falsific. 4, 212; Chem. Centralbl., 1891, part 2, p. 590*).—Sulpho-salicylic acid is said to give in a solution of 1 part of albumen in 100,000 a precipitate which is free from urates, phosphates, alkaloids, etc. The reagent is prepared by heating concentrated sulphuric acid with salicylic acid, allowing the sulpho-salicylic acid to crystallize out, and then recrystallizing from hot water at 120° F. In making the test the solution to be tested is strongly acidulated, 1 or 2 drops of the saturated aqueous solution of sulpho-salicylic acid added, and the solution shaken. The appearance of a cloudiness or a precipitate in a few seconds indicates the presence of albumen. If the precipitate is dissolved by heating and reappears on cooling, peptones are present.

Fat extraction and fat calculation in milk analysis, P. Vieth (*Analyst, 1891, pp. 203–208*).—In a paper on this subject read before the Society of Public Analysts, London, the author expressed the belief that the practical value of a mathematical formula expressing the relation between the specific gravity, total solids, and fat in milk is now very generally acknowledged by analytical chemists who pay more than a superficial attention to milk analysis. The more frequently such a formula is proved to be in accordance with the actual facts the more confidently will it be employed and the more useful will it become. In the laboratory under his charge (that of the Aylesbury Dairy Company, London), where about 18,000 samples of milk are examined annually, the percentage of fat in the bulk of the samples is calculated from the specific gravity and percentage of total solids. But gravimetric fat determinations are made continually, so that the results obtained by analysis have been compared in a large number of cases with those obtained by calculation. In these calculations, the Fleischmann formula is used where the solids are determined by drying the milk on

plaster of Paris, and the Hehner formula where they are determined by the Adams method, using fat-free paper. Out of 628 analyses in 1887 of whole milk and skim milk, in which the fat varied from 0.1 to 10 per cent, the percentage of fat as calculated differed from the percentage of fat found by analysis by from −0.2 to +0.2 per cent, the average difference being +0.02 per cent. The results of more recent comparisons are given in the following table:

Comparison of percentage of fat in milk found by analysis and by calculation.

Year.	Number of samples.	Description.	Maximum differences.		Average differences.
1888	73	Milk	−0.2 to	+0.2	+0.001
	143	Skim milk	−0.2	+0.2	+0.019
1889	55	Milk	−0.2	+0.2	−0.004
	119	Skim milk	−0.2	+0.2	+0.057
1890–91	143	Milk	−0.4	+0.1	−0.143
	207	Skim milk	−0.3	+0.1	−0.048

The author believes the larger average difference obtained in 1890–91 to be due to a change in the method of analysis—drying 5 grams of milk on plaster of Paris instead of 10 grams, as had previously been used. Differences due to this change have been repeatedly observed by him in both the plaster and paper methods, but he is unable to offer any explanation for the difference. Comparisons of the results obtained by the Adams method, using fat-free paper, and by calculation by means of Hehner's formula, show that the average difference in the case of 21 samples of whole milk was +0.03, and in the case of 70 samples of skim milk, 0.6 per cent of fat.

In regard to the manner and extent of the absorption of the milk by the blotting paper in the Adams method, Dr. Veith offers the following explanation:

Milk serum, *i. e.* milk minus fat, must not be considered a simple solution of various bodies in water. Part of the salts, the milk sugar, and part of the proteids are certainly dissolved in the water in the usual sense of the term, but far the greater part of the proteids—the casein—in connection with the rest of the mineral matter, is present in a kind of swollen state, resembling but not identical with solution. * * * In the paper process the watery solution sinks into the blotting paper, and the casein encasing the fat is left on and near the surface. According to this theory the fat is left in contact with only about one third of the non-fatty solids, while about two thirds, including the whole of the milk sugar, are removed from it. That under such conditions extraction of the fat is made easier, can be readily imagined.

Regarding the relative proportion of the constituents of milk solids, it is stated that "speaking as correctly as the case admits, normal milk contains ash, proteids, and milk sugar in the proportion of 2:9:13."

Determination of fat in sour milk, M. Ekenberg (*Chem. Ztg.*, *15*, *p. 1239*).—To make the milk homogeneous, so that an average sample may be taken, it is recommended to add 5 per cent by volume of commercial ammonia, and shake. The milk is rendered thin, and, as microscopic examinations indicated, perfectly homogeneous. Several

determinations, by means of the lactocrite, of the fat in sour milk so treated, showed very nearly the same percentage as had been contained in the fresh sample. A slight error was noticed, however, sour milk 2 days old showing an average decrease of 0.05 per cent in fat as compared with the fresh sample. A correction was therefore made by adding 0.05 to the results obtained by the lactocrite. It is recommended to make the lactocrite test directly after the addition of ammonia. It is essential to accurate results to add the ammonia to the whole volume of sour milk in the vessel in which it soured, instead of attempting to take an average sample from this, and it is therefore necessary to know the exact volume of the sour milk.

Testing milk by electricity, Dohrmann (*Molk. Ztg., 1891; abs. in Vtljahressch. ü. Chem. d. Nahr. u. Genussmtl., 6 (1891), p. 13*).—The test depends upon the fact that when a weak electric current is conducted through a column of milk, changes are induced in the strength of the current which can be measured by a galvanometer. It is claimed that the test furnishes reliable indications as to whether milk has become sour or has been watered. The apparatus consists of a tube through which the milk runs, intercepting a weak electric current which is in connection with a galvanometer, and is adjusted for normal milk at 10° C. A deflection of the needle of the galvanometer to the left indicates sour, and to the right watered milk. The instrument is so arranged that tests can be rapidly executed, a sample of milk being taken automatically from each can, which is cooled to 10° C. by passing through a cooler and then run directly through the column. The accuracy of the apparatus in case of watering has been questioned.

The effect of centrifugal action on the distribution of bacteria in milk, Scheurlen (*Arb. a. d. Kais. Ges. Amt, 7, pp. 269–282; abs. in Chem. Centralbl., 1891, part 2, p. 581, and Milch Ztg., 20 (1891), p. 851*).—After proving that treatment in a centrifuge did not destroy the vitality or virulence of bacteria, the author found further that organisms not capable of motion (anthrax bacilli and spores, *Prodigiosus*, *Staphylococcus aureus*, and tuberculosis bacilli), as well as forms capable of locomotion (*Megatherium*, bacteria causing red milk, *Proteus vulgaris*, and typhoid fever bacilli) when suspended in water gradually sank to the bottom of the vessel if allowed to stand quietly in it from 1 to 4 days, and were partially thrown outward by centrifugal action. *Proteus mirabilis* and Asiatic cholera spirilli were not separated by this treatment in a centrifuge, nor did they sink to the bottom after standing. Tests of cream, skim milk, and dirt from a separator showed that while a considerable number of the bacteria had been separated in the dirt the cream contained many more than the skim milk. A control test made by whirling a tube of milk in a hand centrifuge showed likewise that the larger proportion of the bacteria had been separated with the cream. The author concludes that in the creaming of milk, either

by means of the separator or by setting, by far the larger number of the bacteria contained in the whole milk pass into the cream, the remainder appearing in the skim milk, or a very small amount in the dirt of the separator. The anthrax spores and bacilli, bacteria of typhoid fever, and cholera spirilli follow the same course as the common milk bacteria, that is are largely separated with the cream, but the tuberculosis bacilli are said to form an exception to the rule, being mostly separated by the centrifuge, but sinking to the bottom of the vessel on standing. More or less of the latter, however, remain in the separator milk and the cream. The tests were made with a centrifuge run at the rate of from 2,000 to 4,000 revolutions per minute.

Bacteriological studies of butter, F. Lafar (*Arch. f. Hygiene, 13, pp. 39*).—The author made numerous determinations of the number of bacteria in samples of fresh butter direct from a creamery, and found that in the majority of the samples the number of live germs per gram of butter ranged from ten to twenty millions. About twenty times as many germs were found in samples taken from the surface as in those taken from the inner portions of the material. Of the organisms noticed, two, *Bacterium butyri colloideum* and *Bacillus butyri fluorescens*, occurred in every sample of natural butter examined; sprouting fungi, which were not further studied, and *Bacillus acidi lactici* (Hueppe) occurred often; and *Bacterium ærogenes lactis* (Escherich) was noticed in one case. No molds were noticed in any case. A lengthy description is given of the two typical forms of bacteria isolated.

Samples of fresh natural butter were kept in the cold during winter, and determinations made from time to time of the number of organisms capable of germinating, with a view to observing the effect of continued cold on the vitality of these organisms. A sample kept for 14 days at a temperature ranging from 1° above to 15° below zero C., showed a destruction of only about one third of the organisms. The sample kept on ice for 37 days showed a marked decrease in the number of germs during the first week, but after that kept without further loss. Samples kept at room temperature (12° to 15° C.) increased rapidly in the number of organisms for the first few days, but after that, with the increasing rancidity of the butter, the organisms rapidly diminished in number. It was noticed that *Bacillus butyri fluorescens*, which occurred in large numbers in the fresh samples, decreased in number with the increasing rancidity. It was noticed with samples kept in the breeding oven at a temperature of 35° C. that after 4 days the number of germs had decreased more than half. This decrease went on regularly until at the end of 34 days the butter contained only 5 per cent of the original number of germs. Protracted cold was therefore less successful in reducing the number of germs than the temperature of the breeding oven. Tests of the effect of adding salt to butter kept at a low temperature indicated that while the addition of salt considerably

diminished the number of bacteria, an addition of 10 per cent of salt, was not sufficient to completely destroy all of the germs.

Samples of artificial butter were examined according to the same methods used for natural butter. The number of germinating organisms found in 1 gram of the former was about 750,000, while the smallest number noticed in natural butter was 2,465,555. It is stated further that the appearance of the plate cultures of artificial butter in general was very different from those of natural butter. The forms found in the artificial butter were molds, sprouting fungi, and a bacterium not further described. The effect of cold and of common salt on the germs in artificial butter was tested in the same manner as with natural butter, and the results were found to agree with those obtained for natural butter, the addition of salt up to 13 per cent and exposure to a temperature of —9° C. for 14 days being insufficient to destroy all the germs.

The author announces the above investigations as merely the beginning of work which he proposes in these lines.

The behavior of bacteria of typhoid fever, tuberculosis, and cholera in butter, H. Laser (*Zeitsch. f. Hygiene, 10, pp. 513–520*).—The author refers to the investigations of Heim,* who studied the ability of certain pathogenic bacteria to live in butter. His experiments went to show that cholera germs sown in poor butter slightly sour lost their vitality in a few days, but in butter of the best quality they retained their vitality for over a month. Typhoid fever and tuberculosis germs were found active after remaining in butter the former for 3 and the latter for 4 weeks. Gasperini recognized virulent tuberculosis bacilli among germs which had been in butter for 120 days.

Laser arrived at different conclusions from Heim with regard to the length of time the germs of these diseases are capable of living in butter. He mixed tuberculosis and typhoid fever bacilli and cholera spirilli each in butter and in the fat and casein separated from butter by heating, and made daily examinations of duplicate plate cultures of each material. Colonies of typhoid fever bacilli ceased to be developed on any of the plates after the sixth day, and there was a steady decrease in the number of colonies each day from the first. Cholera bacteria could not be recognized in either the butter or the casein after 5 days, and those in the fat had disappeared by the fourth day. Heim's experiments were carefully duplicated in another series of experiments, but typhoid fever bacilli from fat ceased to develop colonies on the fifth, and those from casein or butter on the seventh day.

The vitality of the tuberculosis germs was tested by inoculating guinea pigs. After the germs had been in butter for 6 days their number had diminished, but they still retained their vitality. After 12 days, however, all the bacilli capable of life or infection had disappeared.

*Arb. a. d. Kais. Ges. Amte, vol. 5.

Although disagreeing with Heim as to the length of time pathogenic bacteria can live in butter, the author concludes that the germs of typhoid fever, cholera, and tuberculosis retain their vitality in butter fat long enough (nearly a week) to make infection with these diseases through butter possible.

It was noticed in the above investigation that a larger or smaller number of colonies of *Oidium lactis* developed on every plate culture. Tests of 15 samples of butter of different origin showed the presence of *Oidium lactis* in every case. The author suggests that as *Oidium lactis* has not been noticed in other fats or oils, and as its presence is easily recognized by means of plate cultures, it might furnish an easy and safe means for the recognition of butter fat, which would be of use in some instances.

Investigations of the milk of sixteen thoroughbred Dutch cows during one period of lactation, W. Fleischmann (*Landw. Jahrb., 20 (1891), Supplement* II, *pp. 368*).—In 1889 the author published a report of investigations made on the milk of a herd of Dutch cows at the royal domain of Kleinhof-Tapiau during 1887–88. The object of these studies was to obtain reliable data for judging of the value for dairy purposes of cows bred in east Prussia under the control of the East Prussian Herdbook Society from stock imported directly from Holland. In 1888–89 the investigations at Kleinhof-Tapiau were continued, the herd numbering about 145 cows, 129 of which, on an average, were in milk, and more extensive investigations were made of the milk of 16 cows during one period of lactation.

Observations on the milk of the herd.—The observations extended from October 1, 1888, to October 1, 1889. During this time the cows were milked twice daily, at 4 a. m. and between 4:30 and 5:30 p. m., according to the season of the year. On Monday, Wednesday, and Friday of each week separate samples of the mixed milk of the herd were taken at morning and at night, and the specific gravity and percentage of solids and fat were determined. From these data were calculated the percentage of solids-not-fat, the percentage of fat in the solids, and the total amount of fat contained in the milk.

For feeding the cows were divided into two groups. The first group included those cows which had not reached the fourth quarter in the period of lactation, and the second those more advanced in the milking period and those already dry. Both lots were fed in the barn from October 18 to May 18, receiving during this time about the same coarse fodders, but the first group was fed the larger amount of grain. From the middle of May until the middle of September the entire herd was at pasture; and from the latter date to the close of the experiment they were fed largely in the barn, excluding the cows not in milk. The average yield of milk for the whole year was 8.76 kg. per day or 2,844 kg. per year. The average duration of the milking period was 325 days, the cows being dry on an average about 6 weeks during the year. As the cows were milked at about 4 o'clock in the morning and about 5

at night, the longest period between milkings occurred during the daytime. In accordance with this a somewhat larger amount of milk was yielded at night than in the morning. From October 1 to April 1 the cows averaged 1,325 kg. of milk containing 41 kg. of fat per animal; and from April 1 to October 1 they averaged 1,519 kg. of milk with 50.4 kg. of fat. These averages are said to be somewhat lower than those observed during the previous year, but in both instances the largest yield of milk and of fat occurred during the summer months. In both years the largest average daily yield of milk per cow occurred between April 1 and July 1. In the present experiment the average percentage of solids in the milk of the entire herd was 11.755, of fat 3.214, and of solids-not-fat 8.541 per cent. The specific gravity of the milk at 15° C. ranged from 1.0275 to 1.0312, the fat content from 2.827 to 3.746, and the solids from 10.857 to 12.380 per cent during the entire year. The minimum specific gravity and percentages of fat and solids were confined to the last few days of feeding in the barn and the second day after turning the cows out to pasture in the spring. The author believes that without doubt the change from winter to summer food affected the general condition of a large number of the cows. The maximum daily yield of milk was reached May 30, averaging at that time 12.07 kg. per cow. As mentioned above, the yield of milk was smaller in the morning than that at night, the difference being about 0.5 kg. per cow; and, as has often been observed in the case of the smaller milkings, the morning's milk was richer than the evening's milk. In the morning's milk the specific gravity averaged 0.00018, the fat 0.077, the solids 0.136, and the solids-not-fat 0.06 per cent higher than the night's milk.

The results of this investigation are summarized by the author in the following general statements:

(1) The milk of the larger milkings invariably showed a lower specific gravity and a lower percentage of solids-not-fat than that from the smaller milkings. (2) Taking the averages for the year, the milk from the larger milkings was poorer in respect to every ingredient than that from smaller milkings, especially when the difference in the amount of milk was over 0.5 kg. (3) In winter, however, the milk of the larger milkings, even when the differences in quantity were very small, were richer in solids and fat and the percentage of fat in the solids was higher. (4) A rise or fall in the specific gravity accompanied an increase or decrease in the content of solids-not-fat.

The author gives the following averages and variations for the milk of the cows under trial during the whole year:

Averages and variations of the milk for 1 year.

	Averages for the year.	Variations.	
		In the day's milk.	In the milk of single milkings.
	Per cent.	*Per cent.*	*Per cent.*
Fat	3.214	2.827 – 3.746	2.415 – 3.997
Total solids	11.755	10.857 – 12.380	9.448 – 12.084
Solids-not-fat	8.541	7.747 – 8.781	7.033 – 8.872
Specific gravity	[illegible]	1.0275 – 1.0312	1.0252 – 1.0315

Minima for the milk of the whole herd.

	1888–89.	1887–88.
	Per cent.	*Per cent.*
Fat	2.415	2.591
Total solids	9.448	11.091
Solids not fat	7.033	8.211
Specific gravity	1.0252	1.0286

The specific gravity of the solids was at no time over 1.361 in 1888–89 and 1.374 in 1887–88. The author was surprised to find that the specific gravity of the mixed milk of the herd of 129 cows was on one occasion as low as 1.0252 (at 15° C.). This occurred on the evening of May 20, 1889, on the second day after the cows had been turned out to pasture.

Observations on the milk of single cows.—As mentioned above, these observations were made on 16 cows and extended throughout the period of lactation. The objects were to fix the bounds of individual variation of cows of this breed with respect to quantity and quality of milk, and to secure extensive and reliable data which might possibly be of value in studying the physiology of milk secretion. In selecting the cows, those were taken which had calved at about the same time. The observations commenced April 8 on 15 cows which had calved between January 28 and March 30. The sixteenth cow calved April 30, and observations were commenced at once. For those cows which had calved previous to the beginning of the experiment the total amounts of milk and butter yielded by each up to the time the experiment commenced are given. The cows were all fed alike when well, the food being the same as that of the whole herd on which observations are reported above. From May 18 to September 30 the cows were at pasture, receiving during that time additional food in the form of brewers' grains, wheat bran, or rye. While fed in the barn 4.25–4.75 kg. per day of a grain mixture (composed of 1 kg. each of ground mixed grains and brewers' grains, 1 or 1.5 kg. of wheat bran, 0.75 kg. of sunflower-seed cake, and 0.25 kg. each of peanut meal and palm nut cake) was fed to each cow as long as she remained in milk. To this

was added at different times rye, hay, straw, distillery swill, silage from grass and serradella, common salt, and phosphate of lime. The cows were milked at 4 o'clock in the morning and at between 4:30 and 5:30 at night. The milk of each cow at each milking was weighed and sampled. The specific gravity and the percentage of fat were determined in each sample, the latter in duplicate by means of a De Laval lactocrite. The instruments used were carefully verified before use. The weighing and sampling of the milk were all done under the direct supervision of the laboratory assistant. From the yield, specific gravity, and percentage of fat calculations were made of the total fat in the milking, the percentage of solids (by means of Fleischmann's formula*), and the specific gravity of the solids; and from these data the per cent of solids-not-fat and the percentage of fat in the total solids were obtained for the milk of each cow at each milking. While the cows were at pasture they were only weighed once; during the remainder of the time they were weighed once a week, the weighings being made in the morning after milking, 12–15 hours after the last feeding and 16–19 hours after the last watering. Larger variations in the weights of the animals from week to week were noticed when the animals were fresh in milk than when they were well advanced in the milking period. Careful measurements and observations were made on each cow with special reference to the external physical qualities supposed to furnish indications of the milking capacity of the cow.

For the milk of each day the specific gravity was calculated from that of the separate milkings, with due regard to the quantity of milk at each milking. The percentage of fat for the day was obtained by dividing the total amount of fat yielded in the two milkings by the total milk yield for the day and multiplying the quotient by 100. From the specific gravity and percentage of fat the percentage of solids and other data were calculated by the formula given above. For each month the specific gravity and percentage of fat, and from these the other data were calculated in the same way as for the day's milk. The fat was calculated to butter containing 83.33 per cent of fat by means of the formula

$$x = \text{amount of fat} \times \frac{100}{83.33}, \text{ or amount of fat} \times 1.2.$$

This does not give the actual amount of butter which would be yielded if the cream was churned; to obtain the actual amount the results given by this formula must be decreased about 6 per cent.

The monthly averages for each cow, including percentages of fat, solids-not-fat, total solids, and fat in total solids, the specific gravity, and the daily yield of milk are graphically shown by means of irregular lines. These lines show that in the case of the cows under trial

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* $t = (1.2 \times f) + \left(2.665 \; \frac{100s - 100}{s}\right)$, where t = total solids, f = percentage of fat, and s = specific gravity. Kirchner's Milchwirtschaft, 2 ed., p. 134.

the percentage of fat in the milk increased with the advance of the period of lactation, and that in some cases this increase was particularly marked toward the close of the period. No increase in the percentage of fat was noticed when the cows were turned to pasture in the spring. Previous observations by the author, extending over 10 years, on herds of cows in Mecklenburg showed that in general for several weeks after going to pasture there was a very considerable increase in the percentage of fat in the milk. The author believes that the absence of an increase in this case can not be due to the character of the pasture, as it was of a far better quality than that on which the observations in Mecklenburg were made. The only explanation which he is able to offer is that in the case of the Mecklenburg cows a considerably larger amount of digestible nutrients was consumed daily immediately after being turned to pasture than had been consumed during the stall feeding preceding it. He believes this could not have been true in the case of the cows in the present investigation.

The percentage of solids-not-fat showed no very marked variations, but in the case of several cows the percentage was lower in the middle than at the beginning or end of the lactation. The line showing the monthly variations in the percentage of solids very closely follows all the deviations of that for fat.

With the exception of 2 cows, the percentage of solids and of fat increased with the advance of the period of lactation. In the case of 2 cows, one 12 years old and the other of inferior value for milking purposes, the percentage of solids showed very little variation from beginning to end of the period. The line showing the changes in the percentage of fat in the total solids of the milk is of especial interest. With regard to the factors governing this percentage, three conditions are conceivable: (1) An increase in the solids-not-fat proportional to the increase in the fat, *i. e.* the milk retaining its relative fat content and becoming only absolutely richer in fat with the advance of the period; (2) a relatively greater increase in the solids-not-fat than in the fat, *i. e.* the milk becoming absolutely richer but relatively poorer in fat with the advance of the period; (3) a relatively smaller increase in the percentage of solids-not-fat than in that of fat, *i. e.* the milk becoming not only absolutely but also relatively richer in fat. With the single exception of the 12-year-old cow, the line showing the percentage of fat in the solids shows a greater or less increase from the beginning to the end of the period, that is the milk of the cows under trial became both relatively and absolutely richer in fat with the advance of the period. While the total activity of the milk glands decreased more and more with the advance of lactation, that part of the energy devoted to the secretion of the fat decreased proportionally slowest of all, that is the secretion of fat decreased more slowly than that of the albuminoids, milk sugar, mineral salts, etc.

The line for the specific gravity runs parallel to that for solids-not-fat. In general the yield of milk decreased after the middle of the period. From time to time temporary variations from this rule were noticed, and at such times the percentage of fat in the total solids showed an increase in the case of 8 cows and a decrease in the case of 5 cows. In the case of the majority, therefore, the temporary increase in yield was accompanied by an increase in the relative per cent of fat, that is the milk became relatively richer in fat. These temporary increases in yield, therefore, affected more especially the secretion of fat.

Calculations are made of the milk and butter (with 83.33 per cent fat) yielded by each cow per 500 kg. live weight, and during a period of 300 days. The butter yield varied with the different cows from 82 to 148 kg. The author alludes to the unavoidable effect on the profit of dairying which such differences in cows must have, when with the same food and the same live weight, during a like period of lactation, one cow yields 82 and another 148 kg. of butter, a relation of 100 to 180. For further comparison the cows are arranged in groups of four each with reference first to age and second to live weight, the yield of butter and milk per 500 kg. live weight during a like period of lactation being given in each case. The average results with each group are given in the following statement:

Relation between yield of milk and butter and age and weight of cow.

	Relation between age of cow and yield per 500 kg. live weight.			Relation between weight of cow and yield per 500 kg. live weight.		
	Number of lactation.	Yield during period of lactation.		Live weight.	Yield during period of lactation.	
		Milk.	Butter.		Milk.	Butter.
		Kg.	*Kg.*	*Kg.*	*Kg.*	*Kg.*
Group 1	1 to 2	39.57	118	581	28.74	113
Group 2	3	30.24	126	560	29.80	111
Group 3	5	33.08	126	524	31.22	113
Group 4	5 to 11	28.22	96	489	33.35	129

The above statement indicates that in this case the oldest cows yielded the smallest and those cows in the fifth lactation, in general, the largest amounts; and that the yield of milk per 500 kg. of live weight increased as the live weight of the animal decreased, that is within this breed the lighter cows gave a larger amount of milk in proportion to their weight than the heavier animals. With regard to the butter, while the lightest cows yielded the largest amount, the difference between the heaviest cows and those of medium weight was not marked. If further investigation should show that under otherwise corresponding circumstances lighter cows require proportionally more food for the production of a given quantity of milk than heavy cows, the lighter cows would still possess the advantage that per unit of weight they produce more milk and butter than the heavier animals.

The author states that it is a matter of frequent observation that in the case of the same cow at two different milkings, that milking furnishing the largest quantity of milk will in general be poorer in percentage of solids and fat; and also that the mixed milk of a number of cows in the same stage of lactation and receiving the same food, becomes richer in percentage of solids as the period of lactation advances. Reasoning from these facts, a general rule has been assumed to exist, namely, that individual cows or those breeds of cows remarkable for a large milk yield, give milk which on the average is poorer in solids than the milk of individual cows or breeds of cows of ordinary milk yield. He grants that under certain conditions such may be the case; but believes that the existence of such a general law or rule remains to be proved. With reference to this point the cows under experiment were arranged in groups of four according to the average daily yield of milk per 500 kg. of live weight, and the average composition of the milk is given. The averages for each of these groups are given in the following statement:

Relation between yield and composition of milk.

	Daily yield per 500 kg. live weight.		Composition of the milk.			Fat in total solids.	Specific gravity of milk.
	Milk.	Butter.*	Fat.	Solids-not-fat.	Solids.		
	Kg.	*Kg.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Degrees.*
Group 1	24.18	0.89	3.086	8.523	11.609	26.58	30.6
Group 2	20.84	0.82	3.407	8.430	11.838	28.77	30.0
Group 3	19.76	0.76	3.222	8.474	11.695	27.53	30.3
Group 4	17.30	0.64	3.081	8.406	11.487	26.61	30.1

*Containing 83.33 per cent of fat; calculated from the total amount of fat in the milk.

This table shows that in the case of the 16 cows under experiment, the milk of group 4, giving the smallest quantity, was in no respect richer than that of the groups giving the largest quantity. The averages for groups 2, 3, and 4 show a steady decrease with the decrease in yield in all constituents except in solids-not-fat. The conclusion might be reached that with these cows a decrease in yield of milk was accompanied by a decrease in percentage of solids. He believes that in cases in everyday practice, where it is noticed that the milk of cows giving a large quantity is thin and relatively poor, the explanation may be often found in insufficient nourishment supplied in proportion to the amount of work performed.

An arrangement of the cows in groups of four, on the basis of the average percentage of fat in the milk, brings out the fact that with an increase in the percentage of fat in the milk all of the other ingredients of the milk also increased. In general then, as shown by the percentage of fat in solids, those cows which gave milk absolutely richer in fat, also gave milk relatively richer in fat. The individual ability of the cows to secrete larger amounts of solid materials in the milk

glands did not affect the several milk constituents in the same proportion, but did affect the milk fat in a relatively greater degree than the other constituents.

The author summarizes the results observed with these 16 cows as follows:

(1) With the advance of the period of lactation, the milk of the individual cows became not only absolutely but also relatively richer in fat; that is not only the percentage of fat in the milk, but also the percentage of fat in the solids increased.

(2) In the majority of cases in which there was a temporary increase in the yield of milk, the milk became relatively richer in fat.

(3) In general the per cent of solids and solids-not-fat in the milk was proportional to the per cent of fat.

(4) The milk of those cows which was absolutely richer in fat, was also relatively richer.

(5) On the average, the cows giving a large quantity of milk also gave milk with a high content of solids. The concentration of the milk of cows giving a large quantity was not surpassed by that of cows giving only a small quantity.

(6) So-called butter cows, the milk of which is relatively rich in fat but poor in solids-not-fat, or so-called cheese cows, the milk of which is relatively poor in fat but rich in solids-not-fat, were not found among the cows on trial.

(7) In the milk of all the cows the quantity of fat varied more widely than that of any other constituent.

(8) The specific gravity of the milk of individual cows was found in general to be directly proportional to the percentage of solids-not-fat.

(9) The milk relatively richest in fat was yielded by the youngest cow (No. 1), and that relatively poorest in fat by a cow over 7 years old, which seemed to possess only inferior ability in the secretion of fat.

With regard to the manner in which the milk is secreted, the author puts the following questions, which are suggested by the above results: Are we to assume that in the milk glands of the cow as many different and more or less independent forces are at work as there are constituents of the milk, and that each of these forces provides for the formation of a single constituent of the milk? Or shall we think rather of the milk glands as possessed of forces which are first of all directed to the formation of milk fat, and that the other milk constituents occur in a sense as by-products? Or is neither one of the above cases true? The author does not enter into a discussion of these questions.

It has been shown that the diminution of the activity of the milk glands as the period of lactation advances affects the secretion of fat proportionally less than that of the other milk constituents. It was further observed that fluctuations in the regular flow of the milk during lactation usually affected the secretion of fat. Finally it was observed that not only the degree of concentration of the milk, but to a certain extent the milk yield also seemed to be determined by the relative tendency of the milk glands to secrete fat. The paramount importance of the fat secretion is further evidenced by the fluctuations in the per cent of fat, which are greater than those of any other constituent. In fact, the author states that it would almost seem as if the active forces in the milk glands were occupied to a very large extent with the formation

of fat, or in other words as if the whole milk secretion was more or less controlled by the secretion of fat. He says that if the facts indicated by this experiment should be confirmed by future investigation, the attempts at improvement in the milking qualities by intensive feeding, breeding, selection of individuals, etc., might reasonably be expected to have an effect both on the quantity of milk and on its richness in fat. Further, the fact long believed to be true in practice, that in general it is possible by increasing the amount of food nutrients to make the milk of cows richer in fat, absolutely as well as relatively, would seem to be fully confirmed. From this it would follow that in the case of good cows rations far in excess of the normal rations at present deemed sufficient could be used with good returns.

The action of water on lead pipes, J. H. Garret (*VII Intern. Congress for Hygiene and Demography, London; abs. in chem. Centralbl., 1891, part 2, p. 720.*)—It is stated that previous to being dissolved, the lead in lead pipes used for conducting water is oxidized. This oxidation takes place either through the oxygen dissolved in the water; or through the combined oxygen of the water which is freed by the action of the lead; or by the presence of other metals, in consequence of electrolytic processes; or, and principally it is believed, by the reduction of the nitrates contained in the water. The nitrites by oxidation to nitrates serve as an oxidizing medium, and by access of air provide for the continuous solution of the lead. Alkaline water containing carbonates acts only on new lead pipe, because a layer, probably consisting of a basic carbonate of lead, is soon formed, which protects the pipe from action. Phosphates and silicates are also said to favor the formation of a protecting coating. As to the part played by CO_2 in water conducted in lead pipes, it is explained that the CO_2 first causes a solution of the lead as carbonate, and by the action of PbO on this carbonate an insoluble basic carbonate results, which forms a protective coating on the inside of the pipes. The action of water on lead differs with the temperature, being greatest at 50° C. (122° F.).

EXPERIMENT STATION NOTES.

ALABAMA CANEBRAKE STATION.—G. D. Stollenwerck of Tombigbee, Alabama, has been appointed a member of the governing board vice H. A. Stollenwerck, deceased.

KENTUCKY STATION.—S. E. Bennett, D. V. M., professor of veterinary science in the college, is also veterinarian to the station.

NEW YORK CORNELL STATION.—G. W. Cavanaugh has been appointed assistant in chemistry vice H. Snyder, B. S.

NORTH CAROLINA STATION.—J. S. Meng, B. S., formerly assistant professor of chemistry in the Mississippi Agricultural and Mechanical College, has been appointed one of the assistant chemists of the station. J. R. Harris, third assistant chemist, has resigned, and T. L. Blalock has been promoted to this position.

OKLAHOMA COLLEGE AND STATION.—Work was begun at this station December 1. Fifty-two acres of prairie are to be plowed, 10 acres to a depth of 6 inches and 42 acres to a depth of 3 inches; the field is then to be harrowed with a disk harrow lengthwise, diagonally, and across the furrow. The soil will then be turned over to a depth of 8 inches and harrowed smooth. After plats are laid out duplicate experiments will be made on the new and older land.

At a recent meeting of the board of regents a plan for a two-years preparatory and a four-years collegiate course of study was adopted. R. J. Barker was elected president of the faculty and professor of moral and mental philosophy. A. C. Magruder was elected professor of agriculture and horticulture. J. A. Wimberly was made superintendent of buildings. It is intended to construct at once a laboratory, a residence for the superintendent, a residence and office for the director of the station, and barn and tool house.

PENNSYLVANIA COLLEGE AND STATION.—T. F. Hunt, B. S., has accepted a professorship of agriculture in the Ohio State University.

WASHINGTON COLLEGE AND STATION.—The following officers were elected by the board of regents December 1, 1891: J. O'B. Scobey, professor of agriculture; E. R. Lake, M. S., professor of horticulture, forestry, and botany; C. E. Munn, professor of veterinary science; and G. G. Hitchcock, professor of chemistry. The college will be opened January 13, 1892.

WEATHER BUREAU.—The predictions heretofore made were based on the observations at 8 a. m. and 8 p. m., and were made for the 24 hours from the time the observations were taken. Beginning with the first of January the predictions in each case will cover the time until midnight of the next day. In this way the predictions printed in the morning papers will appear early in the day to which they apply, while those in the evening papers will be for the following day.

The forecasters are also encouraged to predict for the second and third day in advance whenever they think the state of the weather will justify their doing so. This privilege was given them 2 years ago, and they have more and more taken advantage of this liberty, until now such forecasts are very common. One local forecaster was recently so venturesome as to predict for 4 days in advance, and was so fortunate as to have his prediction verified. These long-range predictions are somewhat less certain than the shorter ones, but their usefulness and their interest justify the Weather Bureau in making them. They lay before the public all the

information which the forecaster can glean from the weather map, and if later observations show that they are not likely to be justified, a timely correction is possible.

THE AMERICAN FORESTRY ASSOCIATION.—This Association held its annual meeting December 29 and 30, at the Department of Agriculture and the National Museum. The chief work of the Association at present is directed toward securing reservations of public timber lands, which shall be placed under national administration.

A memorial presented to the President of the United States during the summer asked that he exercise the authority granted him under the act of Congress of March 3, 1891, by making reservations designated by the following names: Minnesota National Park, Minnesota; Pikes Peak Reserve, Colorado; Tulare Reserve, California; Flathead and Marias River Reserve, Montana; and Pecos and Canadian River Reserve, New Mexico. The lands comprised in these reservations are now being examined to ascertain the desirability of reserving them.

During the meeting a second memorial was presented to the President recommending further reservations as follows: Crater Lake Reserve, Oregon; Lost Park Reserve, Colorado; Turtle Mountain Reserve, North Dakota; and Sierra Madre Reserve, California.

The general object of the proposed national forest reserve is not to withdraw these lands absolutely from occupation or use, but rather to increase their usefulness and the sum total of the productiveness of the territory, by making each acre do its utmost for the benefit of our people.

In the case of these reservations it is the purpose—

To minimize the destruction of forest areas by fires and the wasteful and erroneous methods of forest use prevalent.

To maintain and increase the lumber industry by a permanent and continuous yield of forest products on non-agricultural lands, which under the present methods are laid waste by fires and made less productive.

To promote railroading and wood manufacturing industries by providing constant and increasing supplies of the raw material from cultivated forests, and creating a home market for labor and supplies at these manufactories.

To cultivate and develop new growths of valuable timber wherever the matured trees are cut for the market.

To specially guard and protect the sources of our main rivers and lakes and thus continue their flow for the benefit of the people at large.

To prevent these lands from being taken for timber only and abandoned after cutting the best, and also to secure *bona fide* settlements on the agricultural sections.

Nor is it the purpose to prevent prospecting for minerals, opening of mines, or other legitimate and rational use and development of these lands.

To attain these objects the American Forestry Association urges not only the reservation system, but at the same time the enactment of *administrative* laws which will secure these objects and in a simple manner satisfy all local wants.

One afternoon was devoted to the discussion of the reservation question, in which the Secretary of the Interior made a full statement of his position towards it and pledged his hearty coöperation. Papers were read as follows: By Mr. Gifford Pinchot, on the Development of a Protective Forest Policy in Europe; by J. D. W. French, on the Development of the Forestry Movement in the United States; by C. K. Adams, President of Cornell University, on the Needs of Forestry Education in the United States; and by B. E. Fernow, Chief of the Division of Forestry, Department of Agriculture, on the Proper Management of the National Forest Reservations.

Among the resolutions passed was the following:

Whereas the Association holds that the interests of agriculture are intimately dependent upon a proper forest condition; and

Whereas the Government of the United States has recently made large additional appropriations to the agricultural colleges and experiment stations:

Resolved, That this Association earnestly recommends that forestry be made a part of the curriculum of all agricultural colleges and of the experimental work by the various stations, where this is not done already.

ENGLAND.—The following notes regarding recent plans for education in agriculture and horticulture in England are taken from the *Gardeners' Chronicle* of October 31, 1891:

An important experiment in agricultural education has been started in the rural districts of Kent. In upwards of sixty villages courses of six lectures on elementary scientific subjects bearing upon agriculture are in progresss by university lecturers on the model of the university extension movement. The lecture, the class, the syllabus, the oxyhydrogen lantern, and the traveling libraries, the chief features of university extension, are all put in action. In addition local teachers will be authorized to give supplementary instruction in the intermediate weeks, since, owing to the large area to be covered, the university lecturers can only visit a given village once a fortnight. The lecturers on agricultural chemistry are, Mr. F. M. Legge of Trinity College, Oxford; Mr. H. H. Cousins of Merton College, Oxford; and Mr. R. S. Morrell of Caius College, Cambridge. Mr. W. F. H. Blandford of Trinity College, Cambridge, lectures on injurious insects; Mr. A. S. F. Grünbaum of Caius College, Cambridge, on physiology; Mr. W. B. Bottomley of King's College, Cambridge, on plant life; and Mr. P. Lake of St. John's College, Cambridge, on agricultural geology. The funds are provided by a grant of £3,000 from the Technical Education Committee of the Kent County Council. This is the first systematic attempt, says the *Gardeners' Magazine*, to bring before rural audiences some of the elementary scientific principles which underlie their daily work, and we trust that young gardeners will take full advantage of the lectures and class teaching.

The following is the scheme for forty lectures on horticulture prepared by a committee of the Fruit Growers' Association, and favorably entertained by the Education Department: *First stage.*—Plant life: Seeds, nature of, and germination; requirements of growth, water, heat, air. Soils: Nature and composition. Roots: Nature and functions; branches, fibrils, and root hairs; what they do and how—what helps, what hinders them. Stems and branches: Their nature, work and uses, helps and hindrances. Leaves: What they are, what they do—helps and hindrances. Buds and tubers: Leaf buds, flower buds, tubers. Growth: Increase in size and changes of composition, formation and storage of food materials. Flowers: Their component parts; what they do. Fruit: Changes and development during ripening; forms and varieties, as apple, strawberry, plum, etc. *Second stage.*—Elementary operations: Description and use of implements under each head. Operations connected with the land, with explanations and illustrations of good and bad methods; digging and trenching; draining; hoeing; stirring the soil and weeding; watering. Preparation of seed bed: Rolling and raking; sowing, transplanting, and thinning; potting. Planting: Positions and shelter; staking; earthing and blanching; propagation. Elementary principles: Cutting, budding, grafting, layering; insect and fungous pests. *Third stage.*—Advanced practice; Budding. Grafting and stocks used. Layering. Division. Branching. Root pruning: Old and young trees and bushes. Fruit culture: Open air and under glass; small fruits; apples and pears; stone fruits; gathering and storing; packing and marketing. Vegetable culture: Tubers and roots; green vegetables; fruits and seeds (peas, beans, etc.); rotation of crops. Flower culture: Outside and under glass; manures and application. Treatment of insect pests; treatment of fungi pests. General knowledge of fruits.

FRANCE.—During the past 2 years an experiment station for testing agricultural implements has been in operation in Paris. It was established by the ministry of agriculture, and is under the direction of M. Ringelmann, professor of rural engineering in the national school of agriculture of Grignon. An assistant and a skilled mechanic are also employed. The station is equipped with a steam engine,

dynamometers, and other appliances necessary to its work. Numerous pieces of machinery have been devised to aid in rendering all tests purely mechanical and automatic, and thus to eliminate the personal equation. Tests are made as far as possible under conditions similar to those in actual practice. Both the force which an implement requires for its use and that which it exerts are measured. The working of separate parts of machines is studied with a view to determining where the defects, if any, in construction are to be found. A detailed report of the tests in each case is made to the maker of the implement. A moderate fee is charged for the examinations.

QUEENSLAND.—Bulletin No. 11 of the Department of Agriculture, issued September, 1891, contains "suggestions for building a cool dairy," illustrated with plans of the building described.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING DECEMBER, 1891.

Use of Maize in Europe and the Possibilities of its Extension.

DIVISION OF VEGETABLE PATHOLOGY:

Bulletin No. 1.—Additional Evidence of the Communicability of Peach Yellows and Peach Rosette.

WEATHER BUREAU:

Monthly Weather Review, September, 1891.

DIVISION OF BOTANY:

Bulletin No. 12, December, 1891.—Grasses of the Southwest, part II.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Record, vol. III, Nos. 4 and 5, November and December, 1891.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING DECEMBER, 1891.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF ARIZONA:

Bulletin No. 3, October, 1891.—Irrigation in Arizona.

Bulletin No 4, November, 1891.—Waters and Water Analysis.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF CALIFORNIA:

Bulletin No. 95, December 10, 1891.—Distribution of Seeds and Plants.

AGRICULTURAL EXPERIMENT STATION OF FLORIDA:

Bulletin No. 15, October 1, 1891.—Tobacco and its Cultivation.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF ILLINOIS:

Fourth Annual Report, 1890-91.

AGRICULTURAL EXPERIMENT STATION OF INDIANA:

Bulletin No. 37, December, 1891.—Steer Feeding; A Comparison of Cut with Uncut Clover; Composition and Valuation of Indiana Feeding Stuffs.

LOUISIANA AGRICULTURAL EXPERIMENT STATIONS:

Bulletin No. 12 (second series).—Analyses of Commercial Fertilizers and other Substances useful to Agriculture.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:

Meteorological Bulletin No. 35, November, 1891.

MISSOURI AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 16, November, 1891.—Covering Peach Trees to Protect the Fruit Buds. Spread of Pear Blight; Temperature and Rain Tables; Strawberry Tests; Potato Trials; Seedling Fruits.

NEVADA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 13, October, 1891.—Sugar Beet Experiments.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 33, November, 1891.—Wireworms.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 80, October 1, 1891.—Silos and Silage.

Bulletin No. 80c, October 30, 1891.—The Digestibility of Cotton-Seed Hulls, and of a Ration of Cotton-Seed Hulls and Cotton-Seed Meal; Comparison of Composition and Digestibility of Wheat Straw and Cotton-Seed Hulls; the Fertilizing Constituents Recovered in Manure in these Experiments.

OHIO AGRICULTURAL EXPERIMENT STATION:

Bulletin vol. IV, No. 7 (second series), November, 1891.—The Hessian Fly.

OREGON EXPERIMENT STATION:

Bulletin No. 14.—Notes on Insects.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 3 (new series) October, 1891.—Analyses of Commercial Fertilizers.

TENNESSEE AGRICULTURAL EXPERIMENT STATION:

Bulletin, vol. IV, No. 4, October, 1891.—Some Fungous Diseases of the Grape.

AGRICULTURAL EXPERIMENT STATION OF UTAH:

Bulletin No. 9, December, 1891.—Time of Watering Horses; Whole *vs.* Ground Grain for Horses.

WYOMING AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 3, November, 1891.—The Sugar Beet in Wyoming.

DOMINION OF CANADA.

ONTARIO AGRICULTURAL COLLEGE EXPERIMENT STATION:

Bulletin No. 70, December 1, 1891.—Feeding Grade Steers of Different Breeds.

U. S. DEPARTMENT OF AGRICULTURE

OFFICE OF EXPERIMENT STATIONS

A. W. HARRIS, DIRECTOR

EXPERIMENT STATION RECORD

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EXPERIMENT STATION RECORD.

Vol. III. ISSUED FEBRUARY, 1892. No. 7.

EDITORIAL NOTES.

Agricultural experiment stations are now in operation under the act of Congress approved March 2, 1887, in all the States and Territories except Idaho, Montana, and Alaska. In several States the United States grant is divided, so that 49 stations in 46 States and Territories are receiving money from the United States Treasury. In the States of Alabama, Connecticut, Massachusetts, New Jersey, and New York separate stations are maintained entirely or in part by State funds, and in Louisiana a station for sugar experiments is maintained mainly by funds contributed by sugar planters. In several States branch or substations have been established. If these be excluded, the number of stations in the United States is 55. During the past year 3 new stations have been established, viz, in Washington, Wyoming, and Oklahoma. The stations with this Office received during 1891 about $925,000, of which $680,000 was appropriated from the National Treasury, the rest coming from State governments, private individuals, fees for analyses of fertilizers, sales of farm products, and other sources. The stations employ 473 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors 70, chemists 113, agriculturists 47, horticulturists 50, botanists 30, entomologists 36, veterinarians 22, meteorologists 14, biologists 4, viticulturist 1, physicists 4, geologists 2, mycologists 3, microscopists 2, irrigation engineers 3, in charge of substations 26, secretaries and treasurers 24, librarians 7, clerks 19. There are also 43 persons classified under the head of miscellaneous, including superintendents of gardens, grounds, and buildings, foremen of farms and gardens, apiarists, herdsmen, etc.

During 1891 the stations published 49 annual reports and 255 bulletins. The mailing list of the stations now aggregates about 350,000 names. At a low estimate a total of 40,000,000 pages, containing information on agricultural topics, have been disseminated among the people during the past year; furthermore the results and processes of

experiments are described in thousands of newspapers and other periodicals. The calls upon station officers to make public addresses are numerous and increasing. The station correspondence with farmers is now very large, and touches on nearly every topic connected with farm theory and practice. A number of stations have made exhibits of the processes or results of their investigations at the State and county fairs. There have been many evidences of public approval of the stations and their work, as indicated by acts of the State legislatures in their behalf; gifts of money by local communities, agricultural associations, and private individuals; and by commendations of their work in the agricultural journals as well as by farmers. The relatively large space given to reports of work of the stations in the agricultural press is also an indication of the favor in which the work of the stations is held.

Numerous changes have been made in the officers of the stations during the year. Under present conditions it is inevitable that changes should often occur. A large number of stations have been brought into existence at one time under conditions little known even to local managers. It must be expected that some time will pass before the right men find the right places. There are already evident advantages arising out of transfer of men from one station to another. It is hoped, however, that as the lines of work which each station may most advantageously undertake become more clearly defined, and the advantages of coöperation and of division of labor are better understood, the demands of the work in particular localities and the necessity for restricting the investigations of individual stations to a limited number of problems will tend to develop specialists and to make the tenure of their office much more permanent.

The following statements regarding education and research in agriculture in France are based on a report made to the recent International Agricultural Congress at the Hague, by E. Tisserand.

The system of education and research in agriculture now in operation in France includes (1) schools of agricultural science, (2) higher schools in which scientific and practical instruction in agriculture is given, (3) secondary schools in which the theory and practice of agriculture are taught, (4) schools of apprenticeship, (5) courses in agriculture in connection with institutions for general education or with universities, (6) agricultural experiment stations and laboratories.

In the first class the principal institution is the *Institut National Agronomique à Paris*, in which instruction is given in agricultural science, supplemented by laboratory and field practice. Original researches are also carried on. The object of the school is to train a select body of scientists and investigators to take the lead in promoting the improvement

of agriculture. Many of the graduates become officers of the Government, teachers in the agricultural schools, or investigators in the experiment stations. In this class are also included three veterinary schools.

Next below these in grade are the *Écoles Nationales d'Agriculture*, in which theoretical and practical instruction is combined. The tendency is to make the instruction in these schools more scientific. With these are included the *École Nationale d'Horticulture à Versailles* and the *École des Haras au Pin.*

The third class of agricultural schools includes those which are intended to receive the children of farmers who have finished their primary education, and to give them theoretical and practical instruction in agriculture under the direction of competent, practical agriculturists. A farm is connected with each school. The pupils, forty or fifty in number, perform all the work necessary to the carrying on of this farm, dividing their time equally between manual labor and their lessons, lectures, and laboratory practice. In many of these schools general agriculture is taught, but some are devoted to special lines, such as viticulture, dairying, or irrigation. Military instruction is also given. Boys enter these schools at the age of 13 years and return to the farm 2 or 3 years later comparatively well equipped for the work of life. The expenses of each student for the school year are about $80. The average cost to the Government for the maintenance of such a school is $4,000 per annum.

In the fourth class are those institutions in which a system of apprenticeship is employed. In these schools boys carry on the operations of a farm under competent direction for a period of 2 or 3 years, receiving at the same time a certain amount of general and agricultural instruction. The support of the pupils is provided for by the produce of the farm and by appropriations from the Government. On completing the apprenticeship the student receives a small sum of money as compensation for his labor. These schools are no longer popular. Their number has fallen from 75 in 1852 to 34 in 1891.

Since 1879 instruction in the elements of agriculture, horticulture, and natural history has been obligatory in the normal and primary schools. In each department of France a professor of agriculture is appointed, whose duty it is to prepare a course of instruction in agriculture for the normal school, which shall be suited to the needs of his locality, and to hold farmers' meetings to give instruction in improved agricultural methods.

Chairs of agriculture have been established in many of the "lyceums," colleges, and superior primary schools. Especial development in this line has been noticed during the past 2 years. Experimental and model fields, under the direction of the departmental professors or the directors of experiment stations, have been established in many places, where farmers can see and judge for themselves of the value of new methods.

Besides the regularly organized experiment stations there are a number of "agricultural laboratories" for the examination of soils, fertilizers, seeds, insects, etc., with a view to protecting the farmers against fraud or injury. A number of the experiment stations are devoted to special lines of investigation, as dairying, testing of seeds, plant diseases, fermentations, technology, entomology, sericulture, vegetable physiology, fats and oils, and testing of agricultural implements.

The growth of the system of education and research in agriculture in France during the past 20 years may be illustrated by the following summary:

	1870.	1891.
(1) Schools of agricultural science		Institut National Agronomique with 21 professors and 31 other officers.
	3 veterinary schools with 18 professors and 9 other officers	3 veterinary schools with 24 professors and 18 other officers.
(2) Higher schools of agricultural theory and practice.	3 schools with 19 professors and 16 other officers.	5 schools with 45 professors and 27 other officers.
(3) Secondary agricultural schools.	1 school of irrigation and drainage with 1 professor.	34 schools, including 4 dairy schools, with 197 professors and 95 other officers.
(4) Apprenticeship schools	52	34, including 2 dairy schools for girls.
(5) Courses in agriculture in connection with institutions for general education or with universities.	4 professorships of agricultural chemistry and 10 of agriculture.	5 professorships of agricultural chemistry, 90 of agriculture in the departments, and 38 in lyceums, colleges, and superior primary schools. Instruction in agriculture obligatory in the normal and primary schools.
(6) Institutions for researches in agriculture.	6 stations and laboratories	60 stations and laboratories. Experimental and model fields in all the departments of France.

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Alabama College Station, Bulletin No. 28, November, 1891 (pp. 11).

WATERMELONS AND CANTALOUPES, J. S. NEWMAN AND J. CLAYTON.—In an experiment with reference to the relative productiveness of seeds from different parts of the watermelon, the seeds from the stem and blossom ends produced in each case 435 merchantable melons per acre, while the seeds from the middle produced 507 per acre, weighing over 2 tons more than those from the ends. Six sevenths of the melons from the "middle" seed were ripe August 4, while only one half of those from the "stem end" seed were ripe August 11. Tabulated data are given for 19 varieties tested in 1891. The greatest variation in the ripening of these varieties was only 6 days. The seed of a number of varieties, which had been kept since 1888, failed to germinate. "As a combination variety for home use and market, the Jones melon ranks first. It is not so good for shipping as the Kolb Gem, but superior in quality. The Sugar Loaf gives great satisfaction for home consumption."

Tabulated data are also given for 25 varieties of cantaloupes. The varieties reported as best in flavor are Atlantic City, Golden Jenny, Improved Pineapple, Netted Gem, and Netted Nutmeg.

Arizona Station, Bulletin No. 3, October, 1891 (pp. 15).

IRRIGATION IN ARIZONA, V. E. STOLBRAND, C. E.—This is a bulletin of information regarding the sources of supply of water for irrigation in Arizona, the canals already in service in the Territory, the cost of constructing and operating pumps, projected irrigation works, the resources of some of the counties, and explanations of the "duty of water" and the "miner's inch." It is the intention of the department of irrigation of the University of Arizona, with which the station is connected, to collate data regarding the irrigated and irrigable area in Arizona, with a view to the development of an irrigation system adequate to the needs of this section.

Arizona Station, Bulletin No. 4, November, 1891 (pp. 16).

WATERS AND WATER ANALYSIS, C. B. COLLINGWOOD, M. S.—This includes directions for sampling water for analysis, explanations of the terms used in describing water analysis, and the tabulated results of analyses of a few samples of well and river water in Arizona.

California Station, Bulletin No. 95, December 10, 1891 (pp. 4).

DISTRIBUTION OF SEEDS AND PLANTS, E. J. WICKSON, M. A.—A list of the varieties of seeds and plants which the station is prepared to distribute this season to applicants in its own State. Among the varieties comparatively new to California are the following: Cassava (*Manihot aipi*), taro (*Colocasia antiquorum*, var. *esculenta*), Jerusalem artichoke (*Helianthus tuberosus*), a waste-land forage plant (*Sida elliottii*), a reputed anti-gopher plant (*Euphorbia lathyris*), sugar cane, and a Ceylon variety of peas.

Illinois Station, Fourth Annual Report, 1891 (pp. 14).

This is by the trustees of the University of Illinois for the fiscal year ending June 30, 1891, and includes brief statements regarding the buildings, library, and publications of the station; a list of the experiments completed or in progress; and a detailed statement of receipts and expenditures. The field experiments with wheat and corn have been extended to four places in southern Illinois. The dairy house and the university barn, which were destroyed by fire, have been rebuilt, and the station is therefore better equipped than heretofore for feeding and dairy experiments.

Louisiana Stations, Bulletin No. 12 (Second Series), (pp. 32).

FERTILIZERS, W. C. STUBBS, PH. D. (pp. 282–310).—This includes a short, popular discussion on fertilizers; abstracts from the State fertilizer law; the schedule of trade values of fertilizing ingredients; analyses of 72 samples of fertilizing materials, including dissolved boneblack, cotton-seed meal, cotton-seed cake, cotton-hull ashes, tankage, bone meal, fish scrap, dried blood, ammonium sulphate, kainit, sulphate of potash, muriate of potash, and land plaster; and the text of the State law relating to Paris green, with analyses of 16 samples of this insecticide and 3 samples of water.

Missouri Station, Bulletin No. 16, November, 1891 (pp. 21).

EXPERIMENTS IN HORTICULTURE, J. W. CLARK, B. S.—These included an experiment in covering peach trees to protect the fruit buds from injury during the winter; observations on the spread of pear blight; and tests of strawberries, potatoes, and seedling fruits.

Peach trees, winter protection (pp. 3–8).—Notes and tabulated data on an experiment in which four trees, 3 years old, were bent over to the ground and covered with straw to the depth of about 1 inch.

A self-regulating maximum and minimum thermometer was placed inside with each tree. One of these trees was supplied with an arrangement for ventilation, and was opened regularly in the morning and closed at night. The other tree was opened once a day and then only long enough to read the thermometers. The two remaining trees were not opened from the time they were covered until they were uncovered in the spring. * * *

The effects of covering trees, as shown by this experiment, were:

(1) Trees covered during cold weather were subject to less variation of temperature than when unprotected. This was more marked when the change was sudden and of short duration.

(2) In cold weather the trees were warmer and in warm weather they were colder than the outside atmosphere. * * *

(3) No perceptible injury was done to the trees or the crop in laying the trees down. They blossomed as full and set their fruit as well as trees not treated. They also held and ripened their fruit and made as healthy a growth as the other trees.

Pear blight (pp. 8–10).—Observations on the station orchard are reported which indicate that the germs of the pear blight (*Micrococcus amylovorus*) spread in the direction of the prevailing winds, and that the blight works downward on the trees.

Temperature and rainfall (pp. 11, 12).—A tabulated record of the minimum and maximum temperatures and of the rainfall at Columbia, Missouri, April–September, 1891.

Strawberries (pp. 12–16).—Notes and tabulated data on 102 varieties.

Potatoes (pp. 17–21).—In a test of 19 varieties grown from Northern seed (1891) and home-grown seed of the second and third years' planting (1889 and 1890) from Northern seed, the yield was largest in the case of 10 varieties from Northern seed of 1891. Tabulated data are also given for 68 varieties tested at the station. Dictator and Early Sunrise have been the most productive varieties during the past 3 years.

Seedling fruits (p. 21).—A brief note on experiments with grapes, raspberries, and strawberries.

Nevada Station, Bulletin No. 13, October, 1891 (pp. 40).

SUGAR BEET EXPERIMENTS, R. H. McDOWELL, B. S., AND N. E. WILSON, B. S. (figs. 4).—An account of experiments in growing sugar beets at the station and by a number of farmers in Nevada. Data regarding the cultivation and growth of the crop and the analyses of samples are given in notes and tables. At the station and in many cases elsewhere irrigation was employed. The varieties used were Dippe Klein Wanzleben and Vilmorin Improved, from U. S. Department of Agriculture; Desprez, from Grand Island, Nebraska; and Improved Klein Wanzleben and Betterave à Collet Rouge, from Watsonville, California.

The following summaries of the results are taken from the bulletin:

Average analyses of the several varieties, State at large.

Variety of beets.	Total solids.	Sucrose in juice.	Purity.
	Per cent.	*Per cent.*	*Per cent.*
Dippe Klein Wanzleben	18.71	17.06	91.18
Vilmorin Improved	20.62	19.32	95.55
Desprez	15.72	12.57	80.09
Betterave à Collet Rouge	16.60	10.82	65.06
Improved Klein Wanzleben	12.60	11.46	90.97

Average analyses of different varieties grown on the station farm.

Variety.	Solids.	Sucrose.	Purity
	Per cent.	*Per cent.*	*Per cent.*
Dippe Klein Wanzleben	21.79	19.41	89.07
Vilmorin Improved	19.57	17.90	91.46
Desprez, May 18	22.39	20.05	89.54
Desprez, May 19	21.66	20.00	92.33
Improved Klein Wanzleben	20.93	17.88	85.42
Betterave à Collet Rouge	17.12	15.42	90.07
Improved Klein Wanzleben, July 1	16.18	15.07	93.13

As far as is indicated by sugar content alone, those varieties which have done the best over the State at large are Desprez, Vilmorin Improved, and Dippe Klein Wanzleben. * * *

Beets analyzed at this station varied in sucrose percentage from 2.1 to something over 23 (one perfectly fresh sample analyzing 23.8). Forty-six per cent of all samples analyzed contained between 12 and 18 per cent sucrose, and 20 per cent contained over 18 per cent sucrose. * * *

The general average of all samples received is total solids 17.17, sucrose 13.20, purity 76.87 per cent.

This average of sucrose, while not as high as we could desire, is very fair, and exceeds that of Germany last season, which was estimated at 12.55 per cent. Two of the factors quite prominent in lowering this average of sucrose percentage are, lack of proper cultivation, permitting the beets to grow too large, and the raising of beets on strong alkali soils.

Variations of sucrose in upper and lower halves of five samples of beets.

Number of sample.	Total solids.		Sucrose.		Purity.	
	Upper half.	Lower half.	Upper half.	Lower half.	Upper half.	Lower half.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1	10.51	11.51	7.00	8.70	66.60	75.58
2	12.98	12.89	9.50	10.40	73.11	80.68
3	23.01	11.64	4.40	7.50	19.12	64.43
4	14.37	17.14	10.00	14.60	69.58	85.18
5	20.40	19.23	14.90	18.00	73.03	93.60

The following meteorological summary by W. E. Barney shows the climatic conditions under which the station beets were grown:

	May.	June.	July.	Aug.	Sept.	Oct.
Highest temperature (degrees F.)	77.0	89.6	95.0	96.0	92.0	77.3
Lowest temperature	30.0	32.5	38.0	37.0	31.0	25.3
Mean temperature	53.6	59.2	68.4	71.2	59.1	51.6
Total precipitation (inches)	2.73	0.41	trace	trace	0.54	trace
Number of cloudy days	8	6	0	1	7	2
Number of days on which 0.01 inch or more of rain fell	14	8	0	0	6	0
First frost					24	

New York Cornell Station, Bulletin No. 33, November, 1891 (pp. 80).

WIREWORMS, J. H. COMSTOCK, B. S., AND M. V. SLINGERLAND (pp. 193–272, figs. 21).—This is a detailed report on breeding-cage experiments with a view to discovering a practical method of preventing the ravages of these pests, and the study of the life history of several common species. Previous notes by the author on wireworms and the means for their repression may be found in Bulletin No. 3 and the Annual Report of the station for 1890 (see Experiment Station Bulletin No. 2, part I, p. 169, and Experiment Station Record, vol. II, p. 502). The breeding and root cages in use at the station are described and illustrated. The experiments reported were in the following lines: (1) Protection of the seed by a coating of Paris green and flour or of tar, and by soaking in a solution of salt, copperas, chloride of lime and copperas or strychnine, or in kerosene oil or turpentine; (2) destruction of the larvæ by starvation in clean fallow or in soil in which buckwheat, mustard, or rape was grown; by the application of kerosene oil, kerosene emulsion, crude petroleum (pure and as an emulsion), poisoned dough, or bisulphide of carbon; and by the use of the fertilizers—salt, kainit, muriate of potash, lime, chloride of lime, or gas lime; (3) destruction of pupæ and adults (click beetles) by fall plowing or by trapping.

Coating seed corn with Paris green and flour (pp. 200–203).—Credit for suggesting this method is given to C. H. Fernald, Ph. D., who proposed it in connection with notes on *Aphodius granarius* in the Annual Report of the Massachusetts Hatch Station for 1888 (see Experiment Station Bulletin No. 2, part I, p. 91). In experiments covering 2 years "the only apparent result of such coating was to retard the sprouting of the seeds. When wireworms did eat seed thus coated they did not appear to be injuriously affected by the poison."

Coating seed corn with tar (pp. 203–205).—The results of the different experiments varied considerably, but in general they show—

That sometimes larvæ will attack seed corn even when it is completely coated with tar. In actual practice but few of the kernels would get a complete coat; it requires considerable disagreeable labor to apply the coating; germination is considerably retarded, even when the kernel has been previously soaked in water; and corn thus treated can not be readily used in a planter.

Soaking seed corn in salt solution (pp. 205, 206).—Corn was soaked in brine from 10 to 20 hours before planting. "This series of experiments, extending over a period of nearly a year, make it evident that corn soaked in a saturated salt solution is as readily eaten by wireworms as if not thus soaked, and no injury results to the wireworms."

Soaking seed corn in copperas solution (pp. 206–208).—"After two seasons of experimentation with the copperas solution we have no results which indicate that wireworms will not eat and destroy seed soaked in this solution as readily as any other, and receive no injury therefrom." The addition of chloride of lime to the copperas solution did not render it effective.

Soaking seed corn in kerosene oil or spirits of turpentine (pp. 208–210).—In experiments made in the fall of 1890 the kernels treated were not attacked by the wireworms, but opposite results were obtained in the following spring, so that the author is not prepared to recommend either of these treatments.

Soaking seed corn in strychnine solution (pp. 210, 211).—Seeds soaked in a solution of 1 part strychnine to 400 or 200 parts of water by weight were "neither distasteful nor destructive to wireworms."

A fungous disease of wireworms (p. 211).—Frequent reference is made to the finding of "fungus-killed larvæ" in the breeding cages. Specimens were submitted to Professor Thaxter, who reported that the disease was probably caused by *Metarrhizium anisopliæ*.

Starvation by clean fallow (pp. 211–213).—In October, 1890, larvæ were placed in cages in which clover and timothy had been sown, and in others containing only a soil made up of sand and garden loam, or of these ingredients together with leaf mold. About a year from that time "just as many wireworms remained alive in the cage where no vegetation had been allowed to grow as in the check cage in which grass had been kept growing. In the cages where no more vegetation had grown than naturally would in a 'clean fallow,' over one half the larvæ were still alive."

Starvation by the growth of certain crops (pp. 213–220).—Experiments were made with buckwheat, Chinese and brown mustard, and rape. Except that no larva was observed to change to a pupa in the cage in which mustard was grown, there was no indication that these crops would prevent the growth of wireworms.

The favorable results reported from growing a crop of rape have no doubt been due in a great measure to the fact that the crop is usually grown and cultivated during the summer months, the period when a large percentage of the wireworms are changing to pupæ. This is a critical period with these pests, for whenever they have been disturbed in our breeding cages at this time the pupæ and the larvæ which are changing to pupæ invariably die soon.

Experiments with insecticides (pp. 220–226).—Kerosene emulsion was found to be more effective than kerosene oil. The former "is readily miscible with water, and can be made to permeate the soil more thoroughly and to a greater depth without as much danger of injury to vegetation.

But neither the emulsion nor the pure kerosene can be profitably applied on a large scale to destroy wireworms."

The results with crude petroleum, pure or in emulsion, were not as promising as those with kerosene emulsion. Sweetened dough poisoned with arsenic, which was used with some success to destroy the click beetles, did not prove attractive to the wireworms. Bisulphide of carbon at the rate of about 150 gallons per acre destroyed the larvæ. "Its use will be practicable and profitable only on limited areas where choice plants are attacked."

Experiments with fertilizers (pp. 226–244).—The experiments with salt indicated that to destroy the wireworms it must be used at the rate of about 8 tons per acre, an amount very destructive to vegetation, and when applied at the rate of 1,000 pounds per acre (a heavy dressing) it "neither drives the wireworms deeper into the soil nor causes them to migrate any appreciable distance." Kainit used in experiments during 7 months seemed to have "but little if any effect on wireworms in the soil even when applied in very large quantities, as from 4 to 9 tons per acre."

It should be noted that these results are diametrically opposed to those obtained by Prof. J. B. Smith of the New Jersey Station. In Insect Life, vol. 4, Nos. 1 and 2, p. 45, Professor Smith says: "I have followed out my inquiries into the action of certain fertilizers as insecticides, and am more than ever convinced that in kainit we have a powerful agent for the destruction of worms infesting sod land. Where this material is used before planting corn even on old sod, cutworms and wireworms will do no injury. In addition I always advise fall plowing to give the winter a chance. Direct experiments in the laboratory show that Elater larvæ will die in soil that contains kainit, though it acts slowly and 2 weeks are required to produce a complete result."

Muriate of potash "had to be used at the rate of from 4 to 6 tons per acre to have any effect on the larvæ, and then it was not as effective as the cheaper kainit or the much cheaper common salt."

"Lime applied at the rate of even 200 bushels per acre, either slaked, unslaked, or as limewater, had no effect upon the wireworms." Chloride of lime was effective only when used at the rate of nearly 6 tons per acre.

Gas lime "applied fresh and at the rate of from 20 to 40 tons per acre was partially effective against wireworms."

Destruction of pupæ and adults (*click beetles*), (pp. 244–250).—The experience of the author leads him to agree with those who recommend fall plowing as an effective means of checking the increase of wireworms. A short rotation of crops is recommended "to farmers having land badly infested with wireworms." The author thus explains the beneficial results which follow fall plowing: In the case of the more common species of wireworms the insect assumes its adult form in August, but "remains in the ground in the cell in which it has undergone its transformation till the following April or May." This quiescent period seems to be necessary to the life of the insect.

In every case where the soil in the breeding cages was disturbed after the insects had transformed, the beetles perished. The only way in which we have been able to rear active adults has been to leave the soil in the breeding cages undisturbed from midsummer till the following spring.

This experience clearly indicates that by fall plowing we can destroy the beetles in the soil, and thus prevent their maturing and depositing eggs the following season. The plowing may be done at any time after July 20, for our experiments show that by that time all the mature wireworms have changed to pupæ. After plowing the soil should be well pulverized and kept stirred up so that the little earthen cells of the pupæ and adults may be destroyed.

A summary is given of the experiments in trapping with poisoned baits, reported in Bulletin No. 3 of the station referred to above. "The best results were obtained by dipping a small handful of fresh-cut clover into Paris-green water and placing the bunches under boards in various parts of the field."

From May 1 to October 1, 1889, six common tubular lanterns were kept lighted in the field every night. Only 80 specimens of click beetles were captured, representing 6 genera and 13 species as follows: *Asaphes decoloratus*, *A. bilobatus*, *A. brevicollis*, *Drasterius dorsalis*, *Athous cucullatus*, *A. rufifrons*, *Melanotus exuberans*, *M. scrobicollis*, *M. communis*, *M. sagittarius*, *M. americanus*, *Corymbites sulcicollis*, and *Dolopius lateralis*.

The wheat wireworm (pp. 251–258).—Notes on observations regarding the life history and habits of *Agriotes mancus*, with a detailed technical description of the larva. Of nearly 1,000 larvæ received it was found that 91 per cent were of this species. From his observations the author thinks it probable that the larval state lasts at least 3 years.

We found that as the summer advanced the worms became less active and destructive, and finally, about November 1, they ceased feeding and descended further into the soil. * * * To what depth they descend in the fall, we can not say further than that they were found near the bottom of the cages which contain about 6 inches of soil. If disturbed during this period of hibernation, which lasts until spring, the larvæ were found to be very sluggish. The soil in the cages frequently became frozen solid, but this did not seem to affect the larvæ. * * * Pupæ were invariably found less than 6 inches below the surface, sometimes within an inch of the surface, even when there was 15 inches of soil below them into which they might have descended. * * * July 10 is the earliest date at which we have found pupæ in our cages. They were most numerous about the middle of the month, and some were still in the pupal state August 20. Adults were first found July 31, thus making the duration of the pupal stage about 3 weeks.

Asaphes decoloratus (pp. 258–262).—Notes on observations regarding the life history and habits of this species, with a detailed technical description of the larva. About 5 per cent of the wireworms examined belonged to this species.

Most of our larvæ were taken from old sod land; a few were obtained in a cultivated field. They range in length from 7mm to 25mm. * * * On one occasion a large larva was seen with a smaller one held between its jaws. This suggested that the larvæ might be partially carnivorous, so we tried to rear some on animal food, [but without success]. * * * Every gradation in size appeared among the larvæ. But the fact that about one third of the larvæ received in May pupated the same season, would indicate that the wireworms reach maturity in 3 years.

As the larvæ mature in May, it is quite possible that they continue feeding all winter. During the latter part of May and the first part of June the larvæ make oval earthen cells in the soil, about three eighths of an inch long. * * * Within these cells the change to a pupa takes place. We have not seen the pupa. On June 27 adults were found on the surface of the soil in some of the cages. The larvæ had been placed in the cages May 13. Thus in $1\frac{1}{2}$ months after the larvæ were received they had made their cells and changed to pupæ; the pupæ had transformed into adults; and these adults had attained their normal color and hardness and had worked their way to the surface. Evidently then the pupal stage is not longer than 4 weeks. * * * Some of the beetles had not emerged from the soil by July 4, but none were found alive in the soil after this date. This indicates that all the adults emerge before fall, but of the further history of the species we know nothing.

Melanotus communis (pp. 262–267).—Notes on observations regarding the life history and habits of this species, with a detailed technical description of the larva.

The duration of the larval period is at least 3 years, for several large larvæ were placed in a cage May 30, 1889, and some changed to adults that year, but one larva kept growing for nearly 2 years, reaching a length of 30 mm. It died in the spring of the second year and was no doubt at least 3 and possibly 5 years old. * * *

The change to a pupa takes place during July. The mature larva forms an earthen cell similar, and probably made in a similar manner, to the cell of the wheat wireworm. This cell is about three fourths of an inch in length and three eighths of an inch wide. Soon after the cell is finished the skin of the larva opens at the sutures on the top of the head and along the median line on the dorsum of the following three or four segments. The white and tender pupa then works itself out, leaving the cast larval skin crowded into one end of the cell. The wing pads, legs, and antennæ of the pupa are folded closely on the breast. In other respects it resembles the beetle, but is nearly one fourth longer and the nine segments of the abdomen are distinctly visible. It is much larger than the pupa of the wheat wireworm, and in addition to the long, sharp bristle at each angle of the thorax it has two similar shorter ones, one each side of the mesal linear depression near the caudal border of the thorax.

The change to a beetle takes place in about 1 month. * * * In our cages the beetle never left its earthen cell until the following spring.

Drasterius elegans (pp. 267–270).—Notes on observations regarding the life history and habits of this species, with a detailed technical description of the larva.

The larvæ were placed in the cage April 24, and were not disturbed for over 2 months. On July 4 recently transformed beetles were found in earthen cells in the soil. * * * The change to a beetle takes place about July 1, but whether the beetles emerge soon, as in the case of *Asaphes decoloratus*, or whether they hibernate in the ground we can not say.

Cryptohypnus abbreviatus (pp. 270–272).—Notes on observations regarding the life history and habits of this species, with a detailed technical description of the larva.

The worms when mature are from 7 mm to 9 mm in length, and closely resemble the young larvæ of *Asaphes decoloratus*. * * * The larvæ were placed in cages of growing grass in the spring and were not disturbed until fall; some remained undisturbed until the next spring. In October one cage contained live beetles in their earthen cells; and in the following May a beetle emerged in another cage. These

facts indicate that the larvæ undergo their transformations during the latter part of the summer and the beetle which is produced normally hibernates in the soil, appearing on the surface early in the spring.

North Carolina Station, Bulletin No. 80, October 1, 1891 (pp. 18).

SILOS AND SILAGE, F. E. EMERY, B. S. (figs. 9).—A popular summary of information on the construction of silos and the storing and feeding of silage. The author estimates that the cost of a wooden roofed silo of two apartments, each 10 by 13.5 feet inside and 20 feet deep, in North Carolina, would be $126.

North Carolina Station, Bulletin No. 80*c*, October 30, 1891 (pp. 14).

DIGESTION EXPERIMENTS, F. E. EMERY, B. S., AND B. W. KILGORE, B. S.—*Digestibility of cotton-seed hulls* (pp. 3–7).—A trial with one Jersey cow nearly dry, lasting from December 1 to 12. The food consisted exclusively of cotton-seed hulls, about 20 pounds per day. The excreta were collected and analyzed the last 4 days. The data obtained during the trial are tabulated. The coefficients found were, ash 27.14, cellulose 27.11, fat 80.61, protein 24.61, and nitrogen-free extract 40.3 per cent. "More nitrogen and phosphoric acid were excreted than fed." This is believed to be due to loss of flesh and to indicate that "cotton-seed hulls did not constitute a maintenance ration for the animal." The digestibility and composition of the cotton-seed hulls are compared with those observed elsewhere for wheat straw.

Digestibility of a ration of cotton-seed meal and hulls (pp. 8–10).—The same cow used in the above trial was fed from December 12 to January 9 a ration consisting of 21 pounds of cotton-seed hulls and 3 pounds of cotton-seed meal per day. The excreta were collected on the last 4 days. From the data obtained the coefficients of digestibility of the ration are calculated.

Fertilizing constituents recovered in manure (pp. 11–14).—The percentage of fertilizing constituents in the hulls and meal are given, together with the total amounts eaten and excreted during the trial. When the mixture of hulls and meal was fed, over 90 per cent of the nitrogen and phosphoric acid and nearly 66 per cent of the potash fed were excreted and recovered in the manure. The amount of fertilizing ingredients in the dung and in the urine during each trial are also compared.

Oregon Station, Bulletin No. 14, December, 1891 (pp. 14).

ENTOMOLOGICAL NOTES, F. L. WASHBURN, B. A. (figs. 4).—Popular accounts of the different orders of insects, a list of fifty species of injurious insects found in Oregon in 1891, and notes on several of these species. A successful experiment by an Oregon farmer in the use of bisulphide of carbon for the grain beetle (*Silvanus surinamensis*) is reported, and

reference is made to Bulletin No. 5 of the station and Bulletin No. 58 of the Michigan Station (see Experiment Station Record, vol. II, pp. 63 and 70) for other accounts of experiments with this insecticide. *Monoxia guttulata* has been injurious to sugar beets in Oregon, but in 1891 was held in check at the station by sprinkling the plants with Paris-green water (1 pound to 50 gallons), to which whale oil soap (3 pounds) was added. Special reference is made to tent caterpillars, and suggestions for their repression are given. *Polycaon confertus* was reported as infesting fruit trees of various kinds, but especially pears.

Pennsylvania Station, Annual Report, 1889* (pp. 282).

LEGISLATION (pp. 7–10).—The text of the act of Congress of March 2, 1887, and extracts of an act of the State legislature relating to the station.

FINANCIAL STATEMENT (pp. 11, 12).—This is for the fiscal year ending June 30, 1889.

REPORT OF DIRECTOR (pp. 13–17).—Brief statements regarding the organization, equipment, and work of the station.

TESTS OF VARIETIES, 1889, W. H. CALDWELL, B. S. (pp. 18–41, plates 4).—A report on tests of varieties of wheat, oats, barley, potatoes, and corn. The tests of the first four of these crops were also reported in Bulletin No. 10 of the station (see Experiment Station Record, vol. II, p. 29), and those for corn in Bulletin No. 11 of the station (see Experiment Station Record, vol. II, p. 127). The present article contains illustrations of ears of corn from 16 of the varieties tested. Reports of previous tests may be found in Bulletins Nos. 6 and 7, and the Annual Report of the station for 1888 (see Experiment Station Record, vol. I, p. 142, and Experiment Station Bulletin, No. 2, part II, p. 121).

FEEDING STANDARDS AND COMPOSITION OF FEEDING STUFFS, H. P. ARMSBY, PH. D. (pp. 42–49).—This includes a popular discussion on feeding and feeding rations, the feeding standards recommended by Wolff, and a compilation of analyses of numerous feeding stuffs taken chiefly from Dr. Jenkins's compilation in the Annual Report of the Connecticut State Station for 1888.

ON THE RELATIONS OF LIVE STOCK TO FERTILITY, H. P. ARMSBY, PH. D. (pp. 50–53).—A popular article on this subject, including a table showing the proportions and value of fertilizing ingredients in a large number of crops, feeding stuffs, dairy products, animal products, etc.

THE SOILING SYSTEM FOR MILCH COWS, H. P. ARMSBY, PH. D., W. FREAR, PH. D., W. H. CALDWELL, B. S., AND G. L. HOLTER, B. S. (pp. 53–112).—The series of experiments reported under this head were on much the same general plan as those on the same subject reported in the Annual Report of the station for 1888 (see Experiment Station

* The Report of the station is published as part II of the Annual Report of the Pennsylvania State College for 1889.

Bulletin No. 2, part II, p. 124), and are mainly a continuation of those experiments with some modifications.

Feeding experiments with soiling crops (pp. 55–67).—"The general plan of this portion of the experiment was to divide it into several periods and feed the various soiling crops [fodder corn, green rye, and clover] and the pasture grass in such amounts that the animals should receive equal amounts of total digestible matter from each. The nutritive effect was to be judged of by the amount of milk produced, taking account of its quality as determined by chemical analysis."

There were ten feeding periods, the duration of which is not given. Hay and a grain ration per animal of 2.2 pounds of wheat bran and 2.2 pounds of a mixture of equal parts of oats and corn coarsely ground were fed in addition to each of the soiling crops, and hay andg rain were fed without soiling during three periods. Two cows were used at the beginning, but one became sick and had to be dropped. The results of the feeding, showing the food eaten and milk produced, are tabulated.

The most satisfactory basis on which to compare pasturage and soiling is the amount of digestible matter which they contain. * * * The nutritive value of this digestible matter is greater or less as it contains a greater or less proportion of protein. * * * Pound for pound of green weight, pasture grass is the most valuable of the crops compared, clover next, and rye third. Corn varies greatly in value according to the time of harvesting, etc. * * *

When grain and hay are fed with the soiling crops an excess or deficiency of protein in the latter may be easily and cheaply corrected.

In such a properly balanced ration the value of pasture grass or of the soiling crops is practically in proportion to the total amount of digestible matter which they contain, without reference to the proportion of protein.

Digestion experiments (pp. 67–97).—These include experiments on the digestibility of fodder from sweet corn cut when "the ears were fit for pulling," and from dent corn (thickly and thinly seeded), Early Amber sorghum, and pasture grass. In all the experiments except that with pasture grass sheep were used, two animals in each case. Two steers were used in the experiment with pasture grass. The duration of each experiment was from 7 to 14 days, exclusive of the preliminary periods. The materials tested were each fed alone. The pasture grass was cut during the spring months from the college campus and consisted largely of blue grass and white clover. It was dried before being fed. The thick-seeded dent fodder corn was from seed sown at the rate of two thirds bushels per acre, and the thin seeded from seed sown at the rate of one half bushel. Both were fed as the ears were beginning to form, and the former was also fed before the ears were formed. The composition of each feeding stuff and the data obtained in the digestion experiments with each are tabulated. The coefficients obtained are given in the following table:

Coefficients of digestibility.

	Sweet corn,		Thin-seeded dent corn.		Thick-seeded dent corn.		Thick-seeded dent corn, younger.		Pasture grass.		Sorghum.	
	Sheep No. 1.	Sheep No. 2.	Sheep No. 1.	Sheep No. 2.	Sheep No. 1.	Sheep No. 2.	Sheep No. 1.	Sheep No. 2.	Steer No. 1.	Steer No. 2.	Sheep No. 1.	Sheep No. 2.
	Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
Dry matter	78.05	76.54	68.00	67.25	73.45	70.92	73.69	71.36	75.65	71.93	61.69	60.91
Crude ash	68.60	69.05	52.24	46.34	43.94	48.10	61.09	60.71	50.49	45.53	39.78	46.50
Crude cellulose	75.56	74.20	61.41	60.06	67.97	64.79	71.96	70.84	76.50	74.59	45.35	41.66
Crude fat	74.39	73.40	73.35	71.61	83.77	81.25	81.64	76.14	74.89	73.99	66.99	66.94
Crude protein	77.34	77.66	55.89	56.78	63.71	56.35	75.16	72.46	76.45	73.98	42.57	37.76
Albuminoids	69.45	69.89	47.51	48.27	48.00	37.44	68.23	64.76	72.74	69.82	......	......
Nitrogen-free extract	81.43	79.58	74.13	74.06	78.83	76.74	75.28	74.61	77.13	73.82	70.84	70.74

The results of earlier investigations on the composition and digestibility of corn fodder are summarized and illustrated by means of diagrams. Previous analyses of pasture grass and of sorghum are also cited.

The composition and digestibility found for the dried pasture grass in 1889 varied considerably from that found in 1888. "The differences in the digestibility of the different samples of pasture grass are as great as those between pasture grass and any of the soiling crops."

Yield and composition of pasture grass (pp. 97–101).—The same piece of land was used for determining the yield as in 1888—a plat 7 rods long and 1 rod wide. The grass was cut with a lawn mower whenever it became long enough, or about once in 6 days. "There was produced for the season ending October 15, 5,719.78 pounds of fresh grass per acre and 1,612.91 pounds of dry material." The composition of the grass is given, and from this the amount of digestible nutrients produced per acre is calculated by means of the coefficients of digestibility given above. The rainfall during the season was very favorable to the growth of grass.

The yield of digestible food ingredients per acre as compared with that in 1888 is given as follows:

Yield of digestible ingredients in pasture grass per acre.

	1889.	1888.
	Pounds.	*Pounds.*
Albuminoids	248.97	160.42
Non-albuminoids	44.97	12.37
Carbohydrates (nitrogen-free extract and fiber)	760.65	529.64
Fat	70.34	40.69

"The yield of the pasture was much greater this year than last, owing largely, undoubtedly, to the more favorable season and the less frequent cutting of the grass. The yield of rye was less and that of clover considerably less than in 1888."

As in the preceding year, the rate of growth of the grass per day at different times in the season is calculated, and this is illustrated by a diagram.

Yield of soiling crops (pp. 101–106).—The yields per acre of rye, clover, and each of the four kinds of corn are given, together with the calculated amounts of food ingredients, and of digestible ingredients contained in the same. The latter are as follows:

Yield of digestible ingredients in soiling crops per acre.

	Rye.	Clover.	Sweet corn.	Thin-seeded dent corn.	Thick-seeded dent corn.	Thick-seeded dent corn, younger.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Albuminoids	166	212	121	151	171	190
Non-albuminoids	67	62	46	69	137	78
Carbohydrates (nitrogen free extract and fiber)	1,149	1,222	866	2,572	4,076	1,314
Fat	81	105	37	110	183	100

Making allowance for the portions of the soiling crops not eaten by the animals, and for the fact that "by our system two soiling crops are grown upon the same ground in the same season," a calculation is made of the edible digestible organic matter in the form of soiling crops yielded by 1 acre of land in one season. These figures are compared with those for pasture grass in the following table:

Yield per acre in one season.

	Pasture grass.	Soiling crops.			
		Rye and dent corn.	Clover and dent corn.	Rye and younger dent corn.	Clover and younger dent corn.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Total edible digestible organic matter	1,125	5,776	5,914	3,145	3,283
Digestible albuminoids	249	328	374	355	401

We may say that in round numbers the above figures show that we can produce from three to five times as much digestible food per acre by means of the soiling crops above named as is produced by pasturage such as is represented by our small plat. * * *

The highest yield of soiling was obtained by growing rather coarse and fairly mature corn, which had to be run through a feed cutter before feeding.

Relative economy of soiling and pasturage (pp. 106–112).—"Our data as to the relative cost of soiling and pasturage are not as complete or exact as might be wished, but we think them of sufficient interest to be presented here. In considering them it must of course be borne in mind that they are based upon a single year's experience, and they must be understood as being suggestive rather than decisive."

Calculations are made of the cost of raising and preparing the soiling crops for feeding, and of the net cost of the grain and hay fed with the soiling crops, making allowance for the value of the fertilizing ingredients. In the feeding trial described above 6.23 pounds of digestible

matter (average of all the periods) was consumed per pound of milk solids produced. Assuming this rate of yield, and that the milk would have averaged 12 per cent of solids, an estimate is made of the amount of milk which might have been produced from the edible digestible food ingredients calculated above for an acre of pasturage and of soiling crops, and the value of the milk at 1 cent per pound. And on the assumption that 25 pounds of milk make 1 pound of butter, worth 25 cents, the net returns per acre from the sale of butter are estimated for each system.

In conclusion, the authors state that "on the whole it seems to us an open question whether the farmer who raises his own grain will find much advantage in the soiling system as practiced here compared with good pastures supplemented during the season of short pasturage by grain or green crops."

COMPARISON OF ENSILING AND FIELD CURING FOR INDIAN CORN, H. P. ARMSBY, PH. D., AND W. H. CALDWELL, B. S. (pp. 113–137).—For the purpose of making this comparison, 4.2 acres were fertilized with 42 two-horse loads of barnyard manure, 125 pounds of dried blood, and 600 pounds of dissolved rock phosphate, and were drilled at the rate of about 0.7 bushels of seed per acre with an "unnamed dent variety." The harvesting of the crop was commenced September 24, at which time the kernels were in milk and the lower leaves in most cases quite dry. The silo was of wood, and contained two pits, each about 10 by 12 feet and 14 feet deep.

The field was divided into three portions, one for each of the two pits of the silo and one for field curing, as follows: For the first pit the 6 outside rows were cut, then 10 rows were left standing and 6 more rows cut, and so on through the field until the pit was filled. For the second pit the middle 6 rows out of each 10 left standing were used, while the remainder of the crop was set up in stooks and cured in the field. * * * The material for both pits was cut about three fourths of an inch long. * * *

The first pit was filled September 24 with 37,717 pounds, cut from 1.27 acres. * * * The filling of the second pit extended from September 24 to October 1, five layers in all being put in. * * * The temperature of the separate layers rose to 35°–40° C. before additional material was put in. The total amount of green material put into this pit was 34,755 pounds, cut from 1.21 acres. [In the case of both pits] the edges and corners of the pit were tramped, and the whole was covered with building paper and straw. Neither pit was weighted. * * *

The portion of the crop used for field curing was cut at practically the same time as that used for silage, and set up in stooks in the field. The green material was not weighed. The fodder was hauled to the barn after having stood about a month in the field and then weighed 9,640 pounds. The area from which it was cut was 0.87 acre. * * *

The rapidly filled pit was opened December 27, and the slowly filled pit on February 8. Considerable moldy silage was found on the top and around the sides of both pits. * * * The silage in the middle was well preserved and of good quality. It seems probable that had we been able to fill the pits a week earlier or had we weighted the material moderately it might nearly all have been well preserved. * * *

In calculating the losses in our experiment it would plainly be unfair to the process of ensiling to include our large loss from molding. In place of assuming any loss from this source we have preferred to calculate simply the loss by fermentation, leaving it to the judgment of the reader what addition to this ought to be made for the small amount of molding which not infrequently occurs.

Analyses were made of the corn put into each silo and of samples of the silage and field-cured fodder. "Only a few samples, however, were taken of the material from the slowly filled pit, and it appeared subsequently that these were not sufficiently numerous to fairly represent the composition of this lot of silage."

The calculated amounts of food ingredients in the green material as harvested in the silage from the rapidly filled pit, not excluding that which molded, and in the field-cured fodder, are given as follows:

Food ingredients in ensiled and field-cured fodder corn.

	Dry matter.	Crude ash.	Crude cellulose.	Crude fat.	Albuminoids.	Non-albuminoids.	Nitrogen-free extract.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Silage:							
Material taken	8,712	741	1,946	292	616	60	5,057
Material recovered	7,775	453	1,937	390	453	193	4,349
Loss	937	288	9	+98*	163	+133*	708
Field-cured fodder:							
Material taken	5,948	433	1,372	182	392	58	3,511
Material recovered	4,700	304	1,183	172	308	60	2,643
Loss	1,248	129	189	10	84	+2*	868

* The sign + signifies an apparent gain.

Out of every hundred pounds of dry matter put into the silo, 10.76 pounds were lost by fermentation and 89.24 pounds recovered in the silage, while in the case of the field curing, out of every hundred pounds of dry matter with which we started we lost 20.98 pounds and recovered 79.02 pounds. Furthermore, we can readily figure out that the 10.76 pounds of dry matter lost from the silage and the 20.98 pounds lost from the fodder contained the following number of pounds of each single ingredient:

	Ensiling.	Field curing.
	Pounds.	*Pounds.*
Ash	3.31	2.17
Albuminoids	1.87	0.91
Non-albuminoids	+1.53	+0.03
Crude fiber	0.10	3.18
Nitrogen-free extract	8.13	14.59
Fat	+1.12	0.17
Total	10.76	20.98

It will be observed that in the above table there is an apparent loss of ash. This of course should not be the case if there were no leakage from the silo, and there is difficulty in explaining this loss even on the supposition that some of the juices of the corn soaked into the ground. * * *

As the general result of this portion of the experiment, then, we may formulate the following conclusions:

(1) The silage lost about one half as much dry matter by fermentation as the field-cured fodder did by fermentation and mechanical losses together.

(2) The silage lost about two fifths as much total protein as the fodder, but over one fourth of its albuminoids was converted into non-albuminoids (a less valuable class of ingredients), while in the case of the field-cured fodder there is no evidence of any such conversion.

(3) The silage lost no woody fiber, while the cured fodder lost a considerable amount of this ingredient, evidently from the breaking off of parts during handling.

(4) The losses of nitrogen-free extract (starchy matter) are about in proportion to the total loss of dry matter, being slightly greater, relatively, in the fodder than in the silage.

The results of experiments on the losses by ensiling and by field-curing fodder corn, reported in the Annual Reports of the Wisconsin Station for 1888 and 1889 (see Experiment Station Bulletin No. 2, part I, p. 206, and Experiment Station Record, vol. II, p. 430), and in Bulletin No. 7 of the Missouri Station (see Experiment Station Record, vol. I, p. 249), are compared with those given above.

"It would appear that under ordinary conditions there is a smaller loss in ensiling than in field curing, although the exact difference in any particular case will depend both upon the care and skill with which the process is carried out and upon the weather during the fall and early winter."

Experiments on the digestibility of the silage and the field-cured fodder corn were made with two grade Devon steers. These feeding stuffs were each fed exclusively for 2 weeks, the first week of each feeding period being regarded as preliminary. The amount fed each animal was 45 pounds of silage from the rapidly filled silo, 35 pounds of silage from the slowly filled silo, which contained a larger percentage of dry matter than the other, or about 16 pounds of cut and shredded field-cured fodder corn per day. The data obtained in the experiments are tabulated. A summary of the results is given as follows:

Coefficients of digestibility.

	Silage from rapidly filled silo.		Silage from slowly filled silo.		Average for silage.	Field-cured fodder corn.	
	Steer 1.	Steer 2.	Steer 1.	Steer 2.		Steer 1.	Steer 2.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Total dry matter	60	67	62	61	62	69	64
Ash	28	40	39	19	32	51	47
Albuminoids	25	30	23	17	24	29	21
Non-albuminoids	100	100	100	100	100	100	100
Crude fiber	60	67	56	56	60	73	69
Nitrogen-free extract	63	70	67	66	66	70	65
Crude fat	85	87	86	86	86	80	79

The results are cited of similar experiments at the Wisconsin Station (reported in the publication referred to above) and at the New York State Station (see Annual Report for 1884, p. 45).

"While the results of these digestion experiments vary somewhat, yet in general they are quite comparable with the results of our own experiment, and taking them all together they appear to indicate with reasonable certainty that there is no material difference in the digestibility

of well-made silage on the one hand and of well-cured fodder on the other, when prepared from the same original material."

From the data given above a calculation is made of the amount of digestible food ingredients per acre in green fodder corn, and in silage and field-cured fodder from the same; and these figures are compared with those for 2 tons of timothy hay.

The results are as follows:

Digestible food ingredients from 1 acre.

	Green fodder corn.	Silage.	Field-cured fodder corn.	Two tons timothy hay.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Albuminoids	184	82	133	108
Non-albuminoids	67	151	69	
Carbohydrates	3,947	3,164	3,030	1,736
Fat	153	263	156	44
Total digestible	4,351	3,660	3,388	1,888

A calculation of the relative cost of field curing and ensiling is made on the basis of 1 ton of field-cured fodder from 3 tons of green material, as follows:

	Silage.	Fodder.
Digestible matter secured	741 lbs.	611 lbs.
Cost of digestible matter:		
Three tons green material at $1	$3.00	$3.00
Loading, cutting, and hauling	1.50	0.50
Stooking	....	0.30
	4.50	3.80
Cost per 100 pounds digestible matter	0.61	0.62

"At the prices assumed it appears that, with such losses as we observed in our experiments, the cost of digestible food per 100 pounds is practically the same in the silage and in the field-cured fodder."

Assuming a loss of 50 per cent of dry matter and 60 per cent of digestible matter if the corn had been cured entirely in the field, a second calculation is made, which gives the cost of 100 pounds of digestible matter in silage at 61 cents and in field-cured fodder at $1.12.

On the whole the above comparison seems to indicate that when fodder is cured under the most favorable conditions it will cost relatively about the same or perhaps a little less than silage; while very unfavorable conditions for curing may make the digestible food in the fodder cost very much more than in the silage. Since, now, the conditions under which the losses observed in the experiments quoted above were experienced were exceptionally favorable to field curing, the conclusion seems justified, that under ordinary conditions ensiling is likely to be a cheaper method of preserving the corn crop than field curing, even after allowing for the cost of the silo, an element not taken account of in the above calculations. It must be left for further investigation to determine the validity of this deduction from comparatively few experiments.

GENERAL FERTILIZER EXPERIMENTS, W. H. CALDWELL, B. S. (pp. 137–158).—This is a report of progress in a series of rotation experiments commenced in 1881 to study the effects of the different fertilizing ingredients used singly and combined, with reference to permanency, total yield of crop, relations of parts of plants, etc., as reported in the Annual Report of the station for 1888 (see Experiment Station Bulletin No. 2, part II, p. 132). The yields are tabulated for each of the 36 eighth-acre plats, as well as the gain of the fertilized over the unfertilized plats. No conclusions are drawn, as the experiment is to be continued.

COMPARATIVE VALUE OF DIFFERENT FORMS OF PHOSPHORIC ACID, H. P. ARMSBY, PH. D., AND W. H. CALDWELL, B. S. (pp. 159–161).—Since 1883 an experiment has been in progress at the station on 12 twentieth-acre plats—

For the purpose of comparing the effects of the three commercial forms of phosphoric acid, namely, soluble, reverted, and insoluble, and also of ground bone, upon the ordinary four-course rotation of this section—corn, oats, wheat, and grass. [A previous report may be found in the Annual Report of the station for 1888, see Experiment Station Bulletin No. 2, part II, p. 132.] * * *

The present report is intended to record simply the results obtained during the past year [1889] and a summary of all the results to date, without entering into all the details of the experiment. In 1889 the plats were in grass. * * *

So far as the relative value of the different forms of phosphoric acid is concerned, the results of this year give us little information, since they are quite discordant in the two series. The average results of such an experiment for a series of years are likely to be more trustworthy than those obtained in any single year. * * *

[The total yields from 1884 to 1889, inclusive, indicate that] upon our limestone soil the ground bone has given the best results. This may be due in part to the small amount of nitrogen contained in the bone in addition to its phosphoric acid. With the other three forms the effect seems to be inversely as the solubility, that is the less soluble the phosphoric acid the greater has been its effect in these experiments thus far.

It is the intention to continue these experiments through a series of years, so as to study the cumulative effect of the manuring.

SYSTEMATIC TESTING OF NEW VARIETIES—GERMINATION TESTS, G. C. BUTZ, M. S. (pp. 162–165).—A reprint of Bulletin No. 8 of the station (see Experiment Station Record, vol. I, p. 295).

SHOULD FARMERS RAISE THEIR OWN VEGETABLE SEEDS? G. C. BUTZ, M. S. (pp. 166–170).—This article was also published in Bulletin No. 10 of the station (see Experiment Station Record, vol. II, p. 28).

NOTES ON NEW VARIETIES OF VEGETABLES, G. C. BUTZ, M. S. (pp. 170–177).—This article was also published in Bulletin No. 10 of the station (see Experiment Station Record, vol. II, p. 29).

EXPERIMENTS ON THE PRODUCTION OF ROOT TUBERCLES, W. A. BUCKHOUT, M. S. (pp. 177–181).—These were in continuation of the experiments reported in the Annual Report of the station for 1888 (see Experiment Station Bulletin No. 2, part II, p. 134).

The first was undertaken [in April] in a small cold frame in the open air, the other two in the greenhouse during the winter. The first comprised twelve tumblers for water cultures and twenty-four 4-inch pots for sand or soil. In the water

cultures the seeds were placed upon pieces of slate cut to fit into the tumblers about an inch below the top, and perforated to allow the roots to run through to the water below. Six of these water cultures were in water alone, and six in water to which a tablespoonful of common compost was added as a fertilizer. In each set two were of distilled water, two of rain water, and two of hard water.

The same general plan was followed with the pots of sand and soil, respectively, except that alternate pots were subject to prolonged heating in order to destroy all germs which they may have contained. * * * Examinations of the roots for tubercles were made May 13, when the plants were 3 to 4 inches high and well established; May 28, just before blossoming; June 15, when just beginning to fruit; and July 2, when full growth was attained and they were beginning to decline.

The results are tabulated and discussed. There are also brief reports on cultures made in the plant house in November and January. The experiments thus far made are summarized as follows:

(1) Root tubercles did not appear in water cultures of any kind.

(2) While the cultures in a sterilized medium, supplied only with distilled water, were not entirely devoid of tubercles, they were produced more tardily, were less abundant, and a less number of the cultures contained them.

(3) On the other hand the addition of a fertilizer rendered the production of tubercles more rapid, more abundant, and in a greater number of cultures.

(4) As to relative abundance of tubercles in sand or soil, the results were conflicting. In general the better developed the plant the better developed the tubercles.

(5) The inequality of the distribution of tubercles upon the roots was very striking. In some cases they were confined to a single one of a score or more of roots all equally well placed. Frequently all which a plant bore were upon two or three roots only, all the others being entirely free from them.

Where roots ran through the pots into the cinders upon which the pots were placed, tubercles were in several places greatly developed, being larger and more numerous than on the roots within.

A careful examination of the roots of two species of *Cæsalpinia* and one of *Mimosa* in addition to those mentioned in the previous report, gave no tubercles whatever, while no case of their absence from the roots of *Papilionaceæ* has yet come under my observation.

THE PERIODICAL CICADA IN PENNSYLVANIA, W. A. BUCKHOUT, M. S. (pp. 182–187).—An account of the life history and habits of *Cicada septemdecim*, with a map showing the distribution of broods in Pennsylvania as determined by replies to a circular of inquiry sent out from the station.

INVESTIGATIONS UPON METHODS FOR DISCRIMINATING BETWEEN PHOSPHATES DERIVED FROM BONE AND THOSE DERIVED FROM SOUTH CAROLINA ROCK, W. FREAR, PH. D. (pp. 188–190).—Brief mention is made of the investigations of von Lorenz* and Stoklasa† on the value for this purpose of the determination of the fluorine in phosphatic fertilizers, and the results are given of determinations of the iron and silica in six samples each of dissolved rock and bone.

The highest amount of iron found in any of the bone goods was 0.67 per cent, while in the dissolved rock the minimum was 1.4 per cent. It would certainly seem,

* Oesterr-Ungar. Zeitsch. f. Rübenzucker-Ind., 17, p. 270; abs. in Centralbl. f. agr. Chem., 18, p. 130.

† Centralbl. f. agr. Chem., 18, p. 444.

therefore, that any goods containing more than 1 per cent of iron should be regarded as of mineral rather than of bone origin. In the case of the silica it was found that the quantities in the bone goods varied much more widely. Excluding a sample [thought to be adulterated], it is observed that the bone in no case contained much more than half as much as the minimum found in the dissolved rock. The difference should be still greater in the case of dissolved bone.

It would seem, in conclusion, that either of these methods might aid very greatly in the discrimination between different phosphates, although probably that in which iron is used as a characteristic might often be used more satisfactorily than the second method. Neither method entails work requiring any considerable apparatus or time.

THE COMPOSITION OF BONE OF VARIOUS DEGREES OF FINENESS AS FOUND IN COMMERCIAL GROUND BONE, W. FREAR, PH. D. (pp. 190–193).—To observe the difference in composition of particles of bone of different fineness, analyses were made of five samples of bone "picked at hazard from a large number." Each of these was separated by screening into fine, fine medium, medium, and coarse particles, the fine including particles less than one fiftieth, the fine medium less than one twenty-fifth, the medium less than one twelfth, and the coarse over one twelfth of an inch in diameter. The results of the analyses of each grade of bone from the several samples follow:

Composition of bone of different grades of fineness.

	Phosphoric acid.						Nitrogen.					
	A.	B.	C.	D.	E.	Av.	A.	B.	C.	D.	E.	Av.
	Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
Fine	19.60	23.85	21.19	23.65	19.21	21.50	3.76	3.15	3.40	3.71	3.70	3.54
Fine medium	18.92	23.90	25.59	24.53	22.22	23.23	4.83	3.74	4.09	3.75	4.31	4.14
Medium	18.94	24.20	25.87	24.54	23.01	23.31	4.82	4.01	4.13	4.13	......	4.27
Coarse	......	......	......	24.77	23.88	24.33	......	......	......	4.48	4.42	4.45

In general the percentage of both phosphoric acid and nitrogen increased with the coarseness of the particles, being perceptibly higher in the coarse than in the fine particles. The effect which these differences in composition of the particles might have on the calculated commercial valuation of the bone is considered, and the conclusion is reached that "for the purpose of valuation any bone may be assumed to be identical in composition in all its grades of fineness, without unfairness to either manufacturer or consumer."

COMPOSITION AND FERTILIZING VALUE OF TANNERY ASHES, W. FREAR, PH. D. (pp. 194, 195).—A summary of the results of analyses by Storer* of fresh and spent tan, and of leached and unleached wood ashes, and an analysis of one sample of ashes from spent tan.

NITROGEN SUPPLY OF CORN, W. FREAR, PH. D., AND H. P. ARMSBY, PH. D. (pp. 195–206, plates 4).—The questions investigated were: "(1) Can corn take up any of its nitrogen indirectly from the atmosphere through the agency of the microörganisms present in the

* Bulletin of the Bussey Institution, vol. II, pp. 26–30.

soil? (2) Can corn obtain its nitrogen from that present in insoluble organic compounds, as in decayed roots, etc., and what is the relative value of nitrogen in this state of combination compared with that present in the form of nitrates?"

A review is given of "the existing theories concerning the assimilation of nitrogen by plants," and of observations on the effects of different nitrogenous fertilizers on corn.

The experiments were made in galvanized iron cylinders 14 inches in diameter and 20 inches deep. A layer of gas coke about 5½ inches deep was placed in the bottom, and above this sand. There were four series of experiments with twelve pots in each series. All received hydrous double silicate of potash and aluminum, precipitated calcium phosphate, gypsum, and ferrous sulphate.

To the first row of pots no other addition was made.

The second received two additions of aqueous soil extract, applied to the roots of the young plant. This aqueous extract contained less than 0.01 per cent of nitrogen, so that the small amount of this ingredient added was of no practical importance.

The third row received its nitrogen in the form of black peat, carefully extracted with water till the latter ceased to take up appreciable quantities of nitrogen. The residual material, carefully dried and pulverized, contained 0.01 per cent of phosphoric acid, 0.25 per cent of potash, 0.75 per cent of nitrogen.

To the fourth row nitrogen was applied chiefly as sodium nitrate, being introduced into the channels of the pots whence it would reach the plants by diffusion through the capillary pores of the soil. * * * A small quantity of ammonium sulphate in solution was introduced about the seed so as to be ready for the young plant. * * *

[The results of the experiment are tabulated, and illustrated by four plates.]

In no case were the conditions such as to secure a full normal development of the plant.

The results show that in all the rows the crop contained greater amounts of nitrogen than were supplied in the seed, but that under the conditions above mentioned the presence of microörganisms obtained from fertile soil did not enable the plants to assimilate more nitrogen than they assimilated where the extract was not used.

The increase in quantity observed may be attributed to the slightly available nitrogen of the sand, so that these experiments give us no definite knowledge that maize is able to take up any free nitrogen from the atmosphere through the soil.

It is also found that under the above conditions of growth maize is unable to utilize peat nitrogen as well as it can that of nitrates. About one twentieth of the nitrogen offered as peat and about one third of that offered as nitrates was taken up in the maize crop. The total crop where nitrates were used was nearly nineteen times greater than where no nitrogen was applied. With peat nitrogen the increase was not quite fourfold.

METEOROLOGY, W. FREAR, PH. D. (pp. 206–223 and 237–278).—The work in 1889 was along the same lines as that reported in the Annual Report of the station for 1888 (see Experiment Station Bulletin No. 2, part II, p. 139), and included observations on atmospheric phenomena, soil temperatures, amount of sunshine, and soil moisture. Monthly summaries of the meteorological observations and weekly crop reports are given in the body of the report and the detailed record of daily observations in an appendix.

The results of the observations on soil moisture are recorded in the following table:

Soil moisture.

Date.	Intervening rainfall.	Days since last rain.	Moisture.	Date.	Intervening rainfall.	Days since last rain.	Moisture.
	Inches.		*Per cent.*		*Inches.*		*Per cent.*
July 2	(*)	....	21.08	Sept. 13	0.52	....	20.44
July 12	0.53	1	12.37	Sept. 23	2.31	2	23.09
July 19	1.55	4	17.60	Sept. 27	0.06	1	24.00
July 26	0.06	7	15.84	Oct. 4	0.09	4	23.13
Aug. 2	1.98	3	15.92	Oct. 11	0.14	....	17.50
Aug. 9	0.45	....	19.56	Oct. 18	0.69	4	20.50
Aug. 16	†2.67	2	21.77	Oct. 25	0.42	2	23.91
Aug. 23	0.003	1	17.05	Nov. 1	1.79	1	22.97
Aug. 30	....	8	17.41	Nov. 8	1.51	....	24.49
Sept. 7	0.69	....	22.61				

*0.56 inch had fallen in the 30 hours preceding sampling. On the day of sampling, rain fell before the hour for taking the sample in the following cases: August 9, 0.02 inch; September 7, 0.47 inch. September 13, 0.17 inch; October 11, 0.01 inch; November 8, 0.42 inch.
† August 14 had a rainfall of 2.25 inches.

It is somewhat surprising to note that the average amount of moisture in the soil this year was only 20 per cent while last year it was nearer 40 per cent, and yet the rainfall during the period of observation was greater this year. No errors in method or computation are discoverable. The samples were taken from the same spot, the principal differences being apparently in the heavier rain showers by which the earth might be compacted, the lack of heavy frosts during the preceding winter making the surface of the soil less porous than if it had been heaved by frost, as well as somewhat thinner vegetation.

The following is the yearly summary of meteorological observations:

Summary of meteorological observations.

	Year 1889.	Winter (October, 1887, to March, 1888).	Growing season (April to September, 1888).
Barometer (inches):			
Mean	30.55		
Highest	30.93 (Mar. 13)		
Lowest	29.01 (May 30)		
Temperature (degrees F.):			
Mean	49.03	35.02	62.11
Highest	92 (May 10)	....	92 (May 10)
Lowest	10 (Jan. 20, 23)	1.00	25 (Apr. 14)
Annual range	82	....	
Mean daily range	18.18	....	20.36
Greatest daily range	63 (Feb. 17)	....	37.00 (Apr. 11, May 24, Aug. 30.)
Least daily range	3 (Nov. 13, Dec. 17)		
Mean daily relative humidity (per cent)	81.79	....	78.80
Rainfall (inches):			
Total	45.03	14.38	26.06
Greatest monthly	6.48 (Nov.)		
Least monthly	1.34 (Feb.)		
Greatest daily	2.35 (May 31)		
Number of days on which 0.01 inch or more rain fell	138	†13	74
Mean percentage of cloudiness	61.86	....	55.28
Number of days on which cloudiness averaged 80 per cent or more	146	82	67
Wind (miles):			
Total movement*	22,671		
Maximum velocity	27.6 (Dec. 20)		
Greatest daily movement	418.7 (Feb. 6)		
Last frost in spring	....	....	May 29
First frost in fall	....	....	Oct. 3

* Omitting June 16, 9 p. m., to July 1, 9 p. m.
† Number of days on which snow fell.

Soil temperatures, in degrees F., June to September, 1889.

	At surface.		Below surface.			
			1 inch.		3 inches.	
Highest	91	(July 10)	91	(July 10)	84.50	(July 10)
Lowest	44	(Sept. 21)	44	(Sept. 21)	49	(Sept. 21)
Daily mean	66.19		66.77		66.51	
Mean daily range	9.97		10.84		7.52	
Greatest daily range	26	(Aug. 30)	21.50	(July 7)	15.50	(July 17)

	Below surface.					
	6 inches.		12 inches.		24 inches.	
Highest	78.80	(July 10)	74	(July 10)	68.50	(July 30, Aug. 2, 3)
Lowest	51	(Sept. 21)	54	(Sept. 28)	55	(Jan. 7)
Daily mean	66.35		65.80		64.22	
Mean daily range	3.48		1.65		0.33	
Greatest daily range	8.50	(Aug. 29)	7.50	(Aug. 14)	2	(July 19)

Principal periods of crop development.

Wheat:
- Headed May 24.
- Ripened July 12.
- Harvested July 12–26.

Hay:
- Clover in blossom May 24–31.
- Harvest ended July 12.

Oats:
- Sown April 12–19.
- Ripening July 12.
- Harvested July 19–26.

Corn:
- Planted May 10.
- Cut September 27–October 4.

The winter was not very favorable to grain, having been quite open, though this was partially offset by the scarcity of hard frosts, so that the wheat and grass was little winterkilled. The spring was warmer than usual, but very wet; still, planting was somewhat earlier than in 1888, and germination was good. The progress of vegetation was seriously arrested by a hard frost May 29, and by the tremendous rainfalls of May 30 to June 1, amounting to 5.04 inches. After this, frequent rains made harvesting quite difficult; the whole season was cold; the rainfall was somewhat above the average, though quite well distributed. Corn cutting was somewhat retarded, and also the potato harvest. Potatoes rotted badly, and corn stover was only of a moderate quality.

RELATION OF METEOROLOGICAL CONDITIONS TO THE DEVELOPMENT OF CORN, W. FREAR, PH. D., AND W. H. CALDWELL, B. S. (pp. 223–229).—This is a continuation of the record of observations reported in the Annual Report of the station for 1888 (see Experiment Station Bulletin No. 2, part II, p. 136). Seed from Champion Pearl White and Piasa Queen varieties was planted May 9.

The method of measurement was as follows: Six plants were selected and the increase in height noted at intervals of several days. For this purpose the tip of each new pair of leaves was used as the point of departure for the days immediately succeeding its appearance. From the figures obtained an average was struck, which was assumed to represent the actual growth for the interval, and by dividing by the number of days intervening the daily rate of growth was obtained. It was hoped that in this manner errors in measurement, arising from the appearance of new nodes of growth, would be distributed over the different plants and thus eliminated. This method can not take into account the variation in the rate of growth due to climatic changes as distinguished from those due to the development

of the special organs of the plant (as ears and tassel), nor to the less noticeable but no less certain difference in the rate of growth caused by a difference in the stage of maturity; it assumes also that increase in the material in the plant, which is doubtless the best measure of its growth, is accompanied by a proportional development of plant organs. All that is claimed for it is that it serves quite well for comparative purposes, even though it does not give results that are absolutely correct. * * * The cold, rainy spring very much retarded growth, so that measurements were not begun till July 5, when the plants of both varieties were about 22 inches high. From August 5 to 9 all the plants tasseled out, after which, in 50 per cent of the cases, little vertical growth occurred, though measurements were continued till the 17th, because of the slight increase in the remaining stalks.

In the following table are shown the mean daily intervals of growth of the six stalks:

Date.	Interval of growth.	Date.	Interval of growth.	Date.	Interval of growth.	Date.	Interval of growth.
1889.	*Feet.*	1889.	*Feet.*	1889.	*Feet.*	1889.	*Feet.*
July 6	0.222	July 16	0.187	July 26	0.200	Aug. 5	0.149
7	0.321	17	0.275	27	0.284	6–9	(total) 0.308
8	0.342	18	0.392	28	0.390	10	0.201
9	0.375	19	0.417	29	0.386	11	0.117
10	0.492	20	0.367	30	0.234	12	0.104
11	0.421	21	0.321	31	0.192	13	0.109
12	0.321	22	0.305	Aug. 1	0.334	14	0.100
13	0.367	23	0.341	2	0.358	15–17	(total) 0.028
14	0.400	24	0.300	3	0.341		
15	0.412	25	0.208	4	0.174		

Comparison of weather for 1887–89 during growth of corn.

	1887.	1888.	1889.
Date of planting	May 12	May 8	May 9
Date of first measurement	May 23	June 18	July 5
Days of interval from planting	11	41	57
Height attained ... inches	3.5	10	22
Date at which greatest height was reached	July 23	Aug. 8	Aug. 17
Days of interval from planting	72	92	100
Height attained ... inches	80	81	111
Mean daily atmospheric temperature ... degrees	70	67	66
Total rainfall ... inches	8.3	11.5	15.91
Days on which more than 0.01 inch of rain fell	31	28	44
Mean daily cloudiness	4.2	4.9	5.4

The difference in temperature between these two seasons [1887 and 1889] is almost equal to the difference in the mean July temperatures of Quebec and Boston; of Burlington, Vermont, and Philadelphia; and of Fort Assiniboin, on the northern boundary of the United States, and Santa Fé, New Mexico. Then, too, in 1889 the rainfall was almost twice as great as in 1887, and the cloudiness at least 25 per cent greater.

The differences in the total vertical development attained are due to differences in variety more than to differences in season, although undoubtedly, with a sufficient temperature, ranker growth is to be expected with greater moisture. It may therefore be concluded that in our climate at least, when there is a rainfall of not less than 8 inches during the period of growth up to the time when final vertical development is attained, the temperature is the controlling element in effecting that development.

[Observations of the relative growth of the corn plant during day and night are recorded in the following table:]

Rate of growth of corn day and night (in thousandths of a foot).

Date.	Day.	Night.	Hourly rate, day (9.5 hours).	Hourly rate, night (14.5 hours).	Maximum temperature.	Minimum temperature.
					Degrees F.	*Degrees F.*
July 5	112	117	11.78	8.07	77	52
6	146	188	15.37	12.96	80	57
7	158	217	16.63	14.96	86	63
8	175	200	18.46	13.79	87	64
9	192	300	20.21	20.68	89.5	65
10	133	287	14.01	19.79	90	66
11	142	179	14.95	12.34	85	57
12	146	221	15.37	15.24	85	60
13	158	242	16.63	16.69	81.5	63
14	188	225	19.79	15.52	84	57
15	79	108	8.32	7.45	71	50
16	129	146	13.58	10.07	75	56
17	158	233	16.63	16.07	81	57
18	150	270	15.79	18.62	81	67.5
19	125	242	13.16	16.69	80	66
20	171	158	18.00	10.90	83	59
21	108	196	11.37	13.52	79.5	56
22	162	179	17.05	12.34	83	60
23	125	192	13.16	13.24	79	55.5
24	83	125	8.74	8.62	76	48.5
25	75	125	7.90	8.62	79	52
26	117	167	12.31	11.52	70	63
27	175	217	18.46	14.96	80	63
Mean	139.4	197.5	14.68	13.62	81	59

The means for daily and nightly growth show that about three fifths of the total growth during 24 hours takes place from 5 p. m. to 7:30 a. m.—during a period that receives some sunshine, it is true, but for only a few hours and of the least intensity. When these rates are reduced to the rate per hour during the two periods, it is observed that the rate by day is really a little greater than that by night under the climatic conditions prevailing this season. While this fact may be in part explained by a slow responsiveness on the part of corn to the influence of light—a point upon which the writer has found no data recorded—we must find its chief explanation in the predominant influence of the heat factor.

Pennsylvania Station, Bulletin No. 17, October, 1891 (pp. 19).

THE VALUE OF COTTON-SEED MEAL AS COMPARED WITH WHEAT BRAN FOR THE PRODUCTION OF BUTTER, T. F. HUNT, B. S.—For the purpose of studying this question twelve cows were divided into two lots, each lot containing three Guernseys, one Jersey, one Ayrshire, and one Shorthorn, mostly grades, and in different stages of the milking period. During three periods, the first two of which lasted 4 weeks and the third 2 weeks, they received the following grain rations per animal: Lot 1, 4 pounds corn meal and 6 pounds bran throughout the experiment; lot 2, 4 pounds corn meal, 2 to 6 pounds cotton-seed meal, and a decreasing amount of bran in the first period; 4 pounds corn meal and 6 pounds cotton-seed meal in the second period; and the same ration as lot 1 in the third period. Both lots received the same amount per head of hay and silage, green rye, or timothy and clover, and corn stover *ad libitum*.

The food consumed and the milk and butter fat produced by each lot are tabulated.

The health of the milch cows was not affected, apparently, by feeding 6 pounds of cotton-seed meal daily per animal, the weight of the animals averaging about 900 pounds per head. * * *

The yield of milk was increased about one fifth when cows were fed cotton-seed meal instead of bran, the cotton-seed meal constituting about three fifths of the grain ration and about one fourth of the total food eaten. The per cent of fat in the milk was not materially changed. The quantity of butter fat produced was therefore appreciably increased by feeding cotton-seed meal in place of bran. * * *

The cows which were fed cotton-seed meal did not require quite so much food to produce a pound of milk as did those fed bran during the same time, but when they were both fed alike those which had been previously fed cotton-seed meal required considerable more food than those fed bran.

During the first two periods butter was made from the milk of each lot and samples sent to commission merchants in New York for grading. Five churnings were made from the milk of each lot by means of the "extractor separator, a machine which makes butter directly from the milk," the milk from each churning being collected during 2 or 3 days. The butter obtained by this means contained from 73.79 to 82.18 per cent of the fat, averaging about 76.85 per cent. The average percentage of fat recovered in the butter was in the case of lot 1 (bran) 85.3, and in the case of lot 2 (cotton seed meal) 86.5 per cent. "Practically, however, there was no difference in the completeness with which the butter was recovered when the extractor separator was used."

On 6 consecutive days the mixed milk of each lot was set in a Cooley creamer at about 45° F. for 24 hours, and the cream obtained from each lot was churned in two separate portions. The amount of butter obtained is not given, but the losses of butter fat in the skim milk and buttermilk were slightly larger in the case of lot 1 (bran). Thus, while the skim milk from lot 1 averaged 0.32 and the buttermilk 0.25 per cent fat, that from lot 2 averaged 0.17 and 0.1 per cent fat, respectively.

The judges to whom the butter was sent all rated the butter from the lot receiving cotton-seed meal considerably lower than that from the lot receiving bran.

Determinations of the melting point were made in eight samples of butter from each lot. This ranged in the butter from lot 1 (bran) from 91° to 97°, and averaged 93° F.; and in the butter from lot 2 (cotton-seed meal) from 96° to 102°, and averaged 99° F.

To recapitulate briefly, the yield of milk was increased about one fifth when cotton seed was fed in place of bran; the losses of fat in butter making were practically the same for both lots where the extractor separator was used, but were slightly larger with the bran-fed lot where the cream was raised by the Cooley system and then churned; the butter produced on cotton-seed meal was rated lower by the judges than that produced by the bran-fed lot; and finally, the cotton-seed-meal butter had a higher melting point (about 6° F.) than the bran butter.

Three young calves were fed daily 1 pound of cotton-seed meal mixed with hot water, in addition to skim milk. Two died, but the third "has made a fair gain."

Tennessee Station, Bulletin Vol. IV, No. 4, October, 1891 (pp. 24).

SOME FUNGOUS DISEASES OF THE GRAPE, F. LAMSON-SCRIBNER, B. S. (pp. 97–118, plate 1, figs. 12).—Popular accounts are given of the black rot, brown rot (*Peronospora viticola*), anthracnose, and leaf blight, with suggestions regarding treatment. There are also general statements regarding the preparation and use of fungicides.

Utah Station, Bulletin No. 9, December, 1891 (pp. 8).

TIME OF WATERING HORSES, J. W. SANBORN, B. S. (pp. 1–5).—Two trials are reported, each with four horses, the object of which was to test the effect on the digestion of the food of watering horses before and after feeding grain. The first trial lasted 3 and the second about 6 months. These trials are not final.

WHOLE VS. GROUND GRAIN FOR HORSES, J. W. SANBORN, B. S. (pp. 6–8).—The grain fed in these trials consisted of oats, wheat, and corn. This was fed ground to lot 1 and whole to lot 2 from May 25 to July 6, and from July 6 to September 21 each lot was reversed. The results, as tabulated, show that lot 1 made no gain on ground grain and lost 75 pounds on whole grain, and that lot 2 gained 20 pounds on whole grain and lost 48 pounds when changed to ground grain. With both lots the losses occurred in the period from July 6 to September 21.

Utah Station, Bulletin No. 10, December, 1891 (pp. 12).

STRAWBERRIES, PEAS, AND BEANS, E. S. RICHMAN, B. S.—Brief notes are given on 34 varieties of strawberries, 39 of peas, 15 of pole beans, 1 of Lima beans, and 18 of bush beans. Of strawberries the most promising varieties are Parker Earle, Thompson No. 7, Gypsy, Bubach No. 5, Jessie, and Captain Jack; of peas, Abundance, Beck Gem, Bliss Everbearing, Burpee Profusion, Champion of England, Laxton Alpha, New Early Prize, Salzer Early May, and The Admiral; of pole beans, Old Homestead and Kentucky Wonder; of bush beans, Early Mohawk, Landreth First in the Market, Challenge Dwarf, and Wardwell Kidney Wax.

Vermont Station, Fourth Annual Report, 1890 (pp. 192).

FINANCIAL STATEMENT (pp. 9, 10).—This includes an account of the receipts and expenditures with reference to the appropriation from the United States for the fiscal year ending June 30, 1890, and to that from the State of Vermont for the calendar year 1889.

REPORT OF DIRECTOR, W. W. COOKE, M. A. (pp. 11–15).—A list of the station publications for 1890, a brief account of changes and improvements at the station, and an outline of the work of the station during 1890.

Fertilizers (pp. 16–33).—Analyses are given of thirty-nine samples of commercial fertilizers, made in connection with the State fertilizer inspection of 1890; and of miscellaneous material sent to the station for examination, among which are bone, ashes, Florida phosphate rock, refuse from wool cleaning, peat, muck, nitrate of soda, muriate of potash, land plaster, and water. In twenty-two samples of the commercial fertilizers analyzed determinations were made of the source of the nitrogen present and its solubility in pepsin solution.

A comparison is made between the average composition of sixteen brands sold in the State in 1889 and 1890. Valued on the same basis (that for 1890) the average commercial valuation of the ingredients in three brands is shown to be $1.84 per ton less in 1890 than in 1889. "The decrease in price of these sixteen brands has been 88 cents [per ton]."

Abstracts of bulletins (pp. 34–54).—Abstracts of Bulletins Nos. 18, 21, and 22 (see Experiment Station Record, vol. II, pp. 74, 377, and 515).

Wool and wool measurements, W. W. Cooke, M. A., and L. R. Jones, B. S. (pp. 55–64).—The object of these observations was, "(1) to learn the character of Vermont Merino wool as compared with wool from other breeds and localities, (2) and more especially to get data to serve as a basis for future experimental work upon conditions affecting the wool fiber." The method of work is described at length. Measurements were made of the diameter of fiber from different parts of the fleeces of four registered Merino sheep—two rams and two ewes. The results of these measurements are given in detail.

"The measurements show the fibers from belly and shoulders to be of nearly equal fineness, those from the belly being a little the finer of the two. The order of fineness and the average diameters are as follows:"

	Centimilli-meters.	$\frac{1}{1000}$ inches.
(1) Shoulder	2.252	0.8866
(2) Belly	2.262	0.8905
(3) Hip	2.327	0.9161
(4) Thigh	2.534	0.9976
(5) Body wrinkle	2.537	0.9988
(6) Neck wrinkle	2.709	1.0665

"Comparison of the measurements on the rams with those on the ewes shows the rams' fibers to be slightly but not markedly larger than those of the ewes."

Effect of food on wool fiber (pp. 63, 64).—An experiment, lasting 3 months, was made with eight registered Merino ewes 2 years old, some of the sheep receiving a nitrogenous and some a carbonaceous ration.

Careful measurements were made upon the wool at the beginning, the middle, and the end of the period, but as the differences between the measurements upon the same individuals were found to be greater than the differences between averages, no conclusions were thought justifiable. * * *

Some of the sheep did not do well, owing to the change of surroundings, and it was found that the fibers of these sheep were correspondingly shrunken in diameter. The fact that the diameter of the fiber is shrunken when the sheep is sick was also noticed in the case of one ewe.

STUDY OF MILK GLOBULES, L. R. JONES, B. S. (pp. 65–69).—This includes microscopic examinations of the milk of sixteen cows (Jerseys Devons, Holsteins, Ayrshires, Guernseys, and grades); a comparison of the size of globules in whole milk and in skim milk; and tests of the accuracy of determinations of the amount of fat in milk by means of the microscope. It was found that "the size of the globules had no direct relation to richness of milk. Filia, the Jersey giving the richest milk, showed fewer of the largest-sized globules than the other Jerseys. Hilda, who was giving the richest milk of the Ayrshires, again showed the smallest globules. Betsey's milk, showing so many large globules, was of medium richness."

Quantitive microscopic measurements were made of numerous samples of milk mounted in capillary tubes, as described by Babcock, and the results obtained were compared with those found by gravimetric analysis. "The most satisfactory results, however, showed wide variations."

THE EFFECT OF SUCCULENT FOOD ON THE CHURNABILITY OF THE FAT IN MILK, W. W. COOKE, M. A. (pp. 70–74).—"During the last 2 years this station has made tests of handling milk by various methods and of milk from many different foods. From the large mass of records thus accumulated it is possible to select quite a number that have a bearing on the question of churnability."

The author uses the term churnability "to denote the thoroughness of the work of skimming and churning." The results of nine tests are presented in which the creaming and churning of milk and cream when succulent food (corn silage, green barley, or pasturage) was fed, were compared in periods of 6 to 8 days with that when dry food (dry corn fodder or hay) was fed. The grain was usually the same in corresponding periods. The number of cows in these comparative tests ranged from one to twelve. The results are tabulated. Assuming "that the milk in each case contained 5 per cent of fat, and that for each 100 pounds of milk there were 75 pounds of skim milk and 20 pounds of buttermilk," the results of three tests were in favor of wet food and those of six in favor of dry food. "If there is any difference in churnability on account of food it is in favor of dry food." The results of numerous determinations of the percentage of solids and fat in the milk of cows changed from dry to wet food and *vice versa*, showed no changes in the percentage of these milk constituents which could be traced to the change of food.

EFFECT OF HEAVY FEEDING OF GRAIN ON THE QUANTITY AND QUALITY OF MILK, J. L. HILLS, B. S. (pp. 75–86).—This experiment was with three cows quite new in milk, and one farrow cow, and lasted about 2 months, terminating in the case of the farrow cow with death from

overfeeding. The first two cows were fed a basal grain mixture, consisting by weight of 8 parts of bran, 4 of middlings, 4 of corn meal, 4 of ground oats, 2 of cotton-seed meal, 1 of gluten meal, and 1 of linseed meal. From January 22 to February 21 this mixture was fed in amounts increasing from 6 to 14 pounds per animal daily. From February 21 to March 17, 12 pounds of grain were fed per animal, from one fourth to three fourths of the grain mixture being replaced by corn meal, and from the latter date to March 29 the grain ration consisted of 3 pounds of bran and 9 pounds of rye. The farrow cow received the following grain ration per day: January 26 to 29, 6 pounds of the above grain mixture; January 29 to February 24, from 6 to 12 pounds of a mixture of bran and cotton-seed meal, half and half; February 24 to March 8, 10 to 12 pounds of a mixture of bran and gluten meal, half and half; March 8 to 14, 10 pounds of bran; and March 14 to 20, 10 pounds of a mixture of one fourth bran and three fourths rye. "There was not much change in the coarse fodder, which consisted throughout of 10 to 15 pounds of hay and 30 to 45 pounds of corn silage per day, to which was added up to March 11 a daily feed of 10 pounds of apple pomace." The milk from every six consecutive milkings was mixed and determinations made of the percentage and total quantities of solids, fat, and casein. "The milk of each cow for 3 days on each increase or continuation of grain feeding was set in deep cold setting, skimmed, and churned separately, and samples of all skim milk, buttermilk, and butter were analyzed." The data obtained are tabulated.

Milk yield.—[No. 1.] In general we may say that, eliminating the records made when off feed, this cow shrunk one third of her yield in 2 months in spite of heavy grain feeding, and that she gave apparently no more return than she would had she been receiving a normal ration.

[No. 2.] From the day the mixed meal was increased in quantity for 1 month and until the character of the grain was changed, the cow responded to every added pound of grain by increased yield at the milk pail. As soon, however, as the wider corn-meal ration was fed the milk flow began to shrink and continued to do so until bran and rye was fed, when the flow kept fairly constant.

[Farrow cow.] This cow responded to increased cotton-seed feed by increasing her milk yield to some extent; she did even better on half bran and half gluten meal, although probably a wider ration, and shrunk on bran and on bran and rye.

Quality of milk.—In the case of No. 1 no connection can be traced between the quality of the milk and the food given; fat remained on the whole constant, while solids and casein increased as lactation continued. [The milk of No. 2 showed only slight changes in composition. In the case of Nos. 1 and 2 the yield of butter was largest on the grain mixture and increased slightly with the amount fed. The butter yield of the farrow cow was perceptibly larger with gluten meal and bran than with any other feed.]

The milk creamed less successfully on bran and rye than on any other feed, a fact which held good with all three cows. As they had less bran then than before, if the effect is due to food the rye must have been a controlling factor. The farrow cow gave the richest skim milk. No connection between food and fat content of buttermilk could be traced.

COMPARATIVE EFFECTS OF HAY, SILAGE, AND CORN FODDER AS FED TO MILCH COWS, J. L. HILLS, B. S. (pp. 86–88).—A trial with

twelve cows. All were fed hay for 2 weeks; five were then changed to cut silage and seven to cut corn fodder and fed 2 weeks longer. The coarse fodders were fed *ad libitum*; the nature of the grain ration is not stated. No data are tabulated, but brief summaries are given for each lot. The results with the individual cows of the same lots were considerably at variance.

LIGHT AND HEAVY MEAL, J. L. HILLS, B. S. (pp. 88–90).—A comparison with eleven cows of (1) 3 pounds wheat bran and 3 pounds buckwheat middlings, and (2) 3 pounds corn meal, 1½ pounds cotton-seed meal, and 1½ pounds linseed meal. The milk was analyzed, set, and churned, and the data obtained are summarized.

"The tests in general may be said to indicate that such light feed as bran is often as good, weight for weight, as heavier meal for quantity and quality of milk, and to add testimony to the belief that milk from such feeds creams less thoroughly than that from heavier meal."

MILKING TWO AND THREE TIMES A DAY, J. L. HILLS, B. S. (pp. 90–92).—Tests were made with two cows, one a farrow Ayrshire, the other a Jersey fresh in milk, which were milked twice and then thrice daily during periods of from 3 to 14 days, frequent samples being taken of the milk. The hours of milking were 5 a. m. and 6 p. m.; or 5 a. m., 1:30 p. m., and 8 p. m. Analyses are given of these samples, and in the case of the Jersey of the milk from each milking, together with the total yield and constituents of milk.

> Less milk was given when the cow was milked three times a day in three trials out of four; in the fourth [lasting 3 days] a marked increase in gross yield followed the change as soon as made, but the second test of the same cow indicated that the effect was only temporary, and that continuance brought about a positive decrease.
>
> The quality of the milk of the whole day was always lowered by milking three times a day. * * * Since less milk of poorer quality was given when the cows were milked thrice daily, it follows that there were less solid ingredients. * * * Under both conditions the cows gave the most milk at the earliest milking, and less at each subsequent milking during the day. When milked but twice a day one cow gave the same quality at both milkings, the other a milk at night that was richer in fat and poorer in sugar than the morning's milk. When milked thrice daily each cow gave the most and poorest milk in the morning, less but the richest milk at noon, and the least but of a medium quality at night. In these fluctuations of quality the fat only is concerned, the casein, sugar, and ash on the whole remaining constant.

MECHANICAL LOSSES IN HANDLING MILK, J. L. HILLS, B. S. (pp. 92–96).—Several trials are reported in which "a carefully weighed amount of milk was creamed or separated, cream and skim milk weighed, cream churned, butter and buttermilk weighed, and everything from beginning to end carefully sampled and analyzed. * * * In nine trials out of ten the sum of fats found in the butter and waste products has been less than that in the original milk, and generally much less. * * * Generally speaking, the casein, milk sugar, and ash have checked out within close limits, the sum found in the products being sometimes more and sometimes less than that present in the whole milk."

In thirty-two other cases during the year the losses were observed incidentally. "In these thirty-two tests but once did the fat in the butter and wastes equal that originally taken in the milk. In this case a decided plus (+ 4.70 per cent) indicates error. In the other thirty one, on quantities of milk ranging from 41.56 to 158.74 (and one 216.69) pounds, from 2.95 to 16,65 ounces of fat, equivalent to from 4.91 to 13.56 per cent, is missing." On an average, 114.64 pounds of milk were taken, and there was a loss of 7.72 ounces of fat, or 8.17 per cent of the original amount. Results of similar tests are cited from the Annual Report of the Maine Station for 1889, p. 130 (see Experiment Station Record, vol. II, p. 648).

The author gives the following summary of the indications from his experiments:

(1) In handling milk for the making of butter there is more or less loss of the solid material. * * *

(2) This loss falls almost entirely on the fat, the solids-not-fat, casein, milk sugar, and ash in the products agreeing fairly well with those in the original milk. * * *

(3) This loss of fat is inversely proportional to amounts of milk used and care taken in its handling, decreasing in percentage of entire fat as the amounts used increase and the care in handling is greater.

(4) This last fact indicates that the loss does not arise from any chemical or bacteriological cause, but is purely mechanical, due to the greater viscosity of cream as compared with skim milk.

Relation of fat and casein in milk, W. W. Cooke, M. A. (pp. 97–100).—"The records of this station contain a large number of analyses of milk from different cows, from the same cows at different periods of their milk flow, and from different dairies. All our own data have been worked over to obtain the results given below, and also all the analyses of milk that give both fat and casein, which have been published by the experiment stations in the United States—in all somewhat over 2,400 analyses."

Summary of milk analyses.

Total solids.	Fat.	Casein.	Milk sugar and ash.
11.00	3.07	2.92	5.01
11.50	3.29	3.00	5.21
12.00	3.50	3.07	5.43
12.50	3.75	3.19	5.56
13.00	3.99	3.30	5.71
13.50	4.34	3.44	5.72
14.00	4.68	3.57	5.75
14.50	4.43	3.79	5.68
15.00	5.38	4.00	5.62
15.50	5.69	4.15	5.66
16.00	6.00	4.30	5.70

There is quite a regular increase from first to last in everything except the sugar, which increases decidedly at first until the total solids reach 13 per cent, and then remains practically constant no matter how much the other solids increase. * * * The casein does not increase as fast as the fat, nor relatively as fast as the fat. * * *

Above 16 per cent total solids and below 11 per cent there are not many analyses on record, but what there are seem to indicate that below 11 per cent the fat falls rapidly and becomes less than the casein, while above 16 per cent the milk sugar remains constant, the casein scarcely increases, and nearly all of the extra solids is composed of fat.

Relative proportion of milk constituents in total solids.

Total solids.	Fat.	Casein.	Milk sugar and ash.
11.00=100	28	26	46
12.00=100	29	25	46
13.00=100	31	25	44
14.00=100	33	25	42
15.00=100	36	26	38
16.00=100	38	26	36

Each of these parts follows a distinct rule. The most remarkable is the casein, which keeps surprisingly close to one fourth of the total solids. It can be said then that normal milk, whether rich or poor, has on the average one fourth as much casein as total solids, though single samples may depart widely from this standard. As the milk becomes richer the fat constantly becomes proportionately smaller.

CREAM RAISING BY DILUTION, J. L. HILLS, B. S. (pp. 100–107).—Numerous trials on this subject have been made at the station, both with deep and with shallow setting, the objects being "to test whether successful gravity creaming could be obtained without the use of ice and to compare the systems in use in the State—deep settings in water and in air and shallow air settings in large and small pans. The Cooley can was used for the first two and shallow tins for the second two. The summer trials were made at the station farm, while those in the winter were made at the station building in the city." These trials were largely made by students under the direction of the author.

Deep setting in water (pp. 100–104).—Milk was cooled or heated to 85°–110° F., the latter being accomplished either by ordinary heating or by the addition of one third of its bulk of hot water at 135°, and then set in Cooley cans in water at 45° to 59° and skimmed after 24 hours. There were four separate series of tests, lasting 9, 6, 9, and 4 days, respectively. Each test included several cows, and in one case the entire herd was used. Analyses were made of the skim milk, and these, together with the calculated loss of fat per 100 pounds of milk set, are given in tables. "Excluding the first trial [in which] there was delay between milking and setting, the warm diluted settings did as good work as the cold settings, the balance being slightly in favor of the former to the extent of 0.13 ounce more fat recovered from 100 pounds of milk. The warm undiluted setting failed as compared with cold setting in each of five trials, and but once equaled the diluted setting."

In a later set of experiments in which "in many ways the conditions were unsatisfactory," three cows were used. "The tests included deep cold setting; the addition of an equal bulk of cold water to the milk and setting cold; the addition of one third bulk of hot water and

setting cold; and the addition of pounded ice in large and small pieces, and of snow to milk and setting cold." The tabulated results show large discrepancies in the results obtained by experienced and inexperienced dairymen. They are believed to indicate "that the addition of snow and ice to milk, producing a sudden chill, gave good creaming; that the addition of cold water in equal bulk, causing quick cooling part way and slow cooling the rest of the way down to 45°, did not do as well; and the value of rapid work in milk setting. There seemed to be no difference in result whether the ice used for diluting was in small or large pieces."

Deep setting in air (p. 104).—Milk was set in Cooley cans, either undiluted or diluted with an equal bulk of cold water (53° F.) or with one fourth bulk of hot water (130° F.). "There is but slight difference in the results, and such as appears has little significance.

Shallow setting in air (pp. 104–107).—Milk was set in both large and small pans, being in each case either undiluted or diluted with an equal bulk of cold water (47° F.) or with one fourth bulk of hot water (115° F.). Four tests were made with each method of treatment. In all cases the milk was skimmed after 48 hours' setting. From the tabulated results "it would appear that diluting with cold water causes loss, and diluting with hot water little gain over undiluted setting."

Summary of results (p. 107):

(1) The usual method of deep cold setting did as effective work as any gravity creaming process and did not carry with it certain disadvantages of other methods.

(2) The addition of snow or pounded ice to the milk in the deep can caused good creaming, perhaps as effectual as with the usual method.

(3) The direct heating of milk by external means and setting at 58° to 60° F. and the dilution of milk with large quantities of cold water and setting at any degree, produced relatively poor creaming whenever used by any of the systems.

(4) The heating and increased fluidity of milk caused by adding from a quarter to a third its bulk of hot water (130° to 150° F.), produced on the whole as effectual creaming when set in water at 58° to 60° or shallow pans in cool air, as was the case with ordinary settings, but it entailed the serious disadvantages of increased tank room, thinner skim milk, and a rapidly souring cream.

(5) There seemed little preference in the use of hot or cold water or of none at all in deep air settings.

(6) In cool shallow setting nothing was gained by dilution, either hot or cold.

(7) Delays in setting and manipulation of the milk prior to setting seemed to affect the creaming of the deep-setting more than that of the shallow-setting systems.

EFFECT ON QUANTITY AND QUALITY OF MILK OF THE CHANGE FROM BARN TO PASTURE, J. L. HILLS, B. S. (pp. 107–110).—Observations are tabulated on the yield and composition of milk on barn feeding and on pasturage of 4 cows calving in the fall, which "were barn fed in such a manner as to give, as nearly as might be, a ration of the same nutritive ratio as they would probably get on pasture"; and of 6 fall cows and 81 spring cows "whose dry barn feed was less nutritive than the pasture."

In general it would appear that cows under the usual Vermont conditions of dry barn feed when turned to pasture may be expected to give more and richer milk, the increase in flow being greatest in new milch cows and the increase in richness greatest in those farther along in lactation, but both quantity and quality increasing more or less in almost every case. When, however, cows pass from a barn to a pasture ration of equal feeding value, more milk, generally richer in total solids, casein, and sugar, and sometimes richer, sometimes poorer in fat, is usually given, which affords increase in gross yield of all milk constituents.

The results of these tests and of many other changes from dry to succulent food which have been controlled by chemical analysis have warranted us in stating the general rule that pasture feeding and watery food do not make watery milk.

MISCELLANEOUS NOTES ON DAIRY WORK, W. W. COOKE, M. A. (pp. 110–113).—These include brief notes on effect of churning at different temperatures (57° and 67° F.), effect of stage of stopping the churn on the quality of the buttermilk, sampling buttermilk, skimming Cooley cans, churning mixed cream (sweet and sour), adding soda to milk (to aid in creaming), and adding ice water to milk.

Three tests were made as to the effect on churnability of mixing sweet and sour cream in equal parts. Sweet cream, sour cream, and mixtures of the two were each churned at 68° F. in the first, "at a little lower temperature" in the second, and at 52° F. in the third trial. The percentage of fat in the buttermilk in each test was as follows:

	First.	Second.	Third.
Sweet cream	2.24	1.77	0.68
Sour cream	0.62	0.25	0.16
Mixture of the two	0.92	1.17	0.66

PIG FEEDING, W. W. COOKE, M. A. (pp. 114–128).—"The experiment began May 12 with all except the small Yorkshire, that did not arrive until May 19. The pigs were about of the same age—2 months, and were fed the same, the food in general consisting of 6 quarts of skim milk per day and three quarters of a pound of either corn meal or middlings. This was given each day of the test. As the pigs grew older, whatever more food they wanted was made up of a mixture of one part by weight of wheat bran to two parts of gluten meal. The pigs were fed all they wanted, or rather all they could be induced to eat."

The tabulated results show for each breed the gains in live weight, food consumed, cost of food per pound of gain, etc., together with the fertilizing ingredients per ton of the skim milk, corn meal, wheat bran, wheat middlings, and gluten meal. The first cost of the feeding stuffs is given as follows: Corn meal, gluten meal, and wheat middlings \$26, and wheat bran \$24 per ton, and skim milk 15 cents per 100 pounds. "The pork was sold at 5 cents a pound, dressed weight."

In brief, the conclusions reached were that in this particular trial—

(1) The Chester Whites grew the fastest.

(2) The Chester Whites and the Poland-Chinas required the most food.

(3) The large Yorkshire made a pound of pork with the least cost of food. But it should be remembered that as showing the relative value of different breeds a single test should carry but little weight, since there is a much larger difference between the different individuals of the same breed than between the average of a large number of individuals of each of the different breeds. The question of breed was considered as of secondary importance in this test, though it was considered that the results of the averages would be more reliable when obtained from individuals of several breeds than if all the pigs had been of one breed.

(4) On the average the six pigs required during the first period 1.59 pounds of dry matter in the food to make a pound of growth, and this amount increased steadily as the pigs increased in live weight, until during the last period, when they weighed about 200 pounds apiece, it required 3.96 pounds of dry matter in the food to produce a pound of growth.

(5) The pigs ceased to yield a profit at the market prices then ruling after they reached a live weight of about 180 pounds.

(6) But it was found profitable then to feed them heavily for 15 days on corn meal to "finish them off" for market.

(7) In every case corn meal gave better results than wheat middlings as food for young growing pigs.

(8) In every case corn meal gave better results than rice bran, producing on the average about a quarter more growth with the same amount of food.

Rice meal vs. corn meal (pp. 125–128).—Four pigs, weighing from 139 to 145 pounds each at the beginning of the trial, were each fed 6 quarts of buttermilk and 4 pounds of grain daily. The grain of one lot was two thirds rice meal and that of the other two thirds corn meal, bran forming the other third in each case. The duration of the trial is not given. Analyses of the feeding stuffs with reference to both food and fertilizing ingredients, the gain in live weight of each lot, and the cost of food per pound of gain, allowing $26 per ton for the corn meal and the rice meal and $24 for the bran, and 10 cents per 100 pounds for the buttermilk, are tabulated. "The corn meal produced 27 pounds, or 23 per cent more gain in live weight than the rice meal."

REPORT OF BOTANIST, L. R. JONES, B. S. (pp. 129–144, fig. 1).—A more detailed account of experiments in the treatment of potato rot, reported in Bulletin No. 24 of the station (see Experiment Station Record, vol. III, p. 101). There are also brief notes on smut of oats, apple rust caused by "cedar apples," onion smut, black knot of plum and cherry, apple scab, black scab of pear, pear blight, strawberry leaf blight, clover rust, leaf spot of currants, cane rust of raspberries and blackberries, ergot, grape mildews, and hollyhock rust, which were more or less prevalent in the vicinity of the station in 1890.

REPORT OF HORTICULTURIST, C. W. MINOTT, B. S. (pp. 145–185).—This includes accounts of tests of varieties of vegetables and small fruits and of an experiment with Bordeaux mixture and Paris green on potatoes.

Beans (pp. 147–150).—Tabulated data for 41 varieties of bush beans, including 10 grown as field beans. For the garden Golden-Podded Wax "still holds the lead." In the field "Aroostook proved the earliest, but the Improved Field set the largest number of pods." Of 6

varieties of pole beans for which data are given, Carmine Wax proved the earliest, but not so prolific as Brockton Pole.

Beets (p. 151).—Tabulated data for 17 varieties. "None proved better than Bastian Turnip.

Carrots (p. 152).—Tabulated data for 16 varieties. "Danvers proved the most satisfactory."

Corn (pp. 153–156).—Tabulated data for 34 dent and 26 flint varieties.

Sweet corn (pp. 157, 158).—Tabulated data for 47 varieties. Cory, Pride of America, Roslyn Hybrid, and No. 48 were the earliest.

Cucumbers (p. 159).—Tabulated data for 13 varieties.

Peas (pp. 160–162).—Tabulated data for 34 early and 25 medium varieties. With a few exceptions there was little difference in the time of edible maturity between the early and medium varieties.

Potatoes (pp. 163–177).—Tabulated data for 172 varieties grown on light clay loam and 64 on heavy clay, and for 42 varieties grown at the station for the first time.

Tomatoes (p. 178).—Tabulated data for 30 varieties. Green Mountain gave the first 10 ripe fruits. Ignotum, Livingston Paragon, and Perfection are especially commended.

Turnips (p. 179).—Tabulated data for 14 varieties.

Swedish turnips (p. 180).—Tabulated data for 16 varieties.

Potatoes, Vermont vs. Maryland seed (pp. 181, 182).—Notes and tabulated data for an experiment in which duplicate plantings of both Northern and Southern-grown seed were made in 1890 at this station and at the Maryland Station, to verify the results of the previous year. The results agreed with those of 1889 in favoring the Vermont seed.

Bordeaux mixture and Paris green on potatoes (p. 183).—Brief notes on a successful experiment with the combined fungicide and insecticide for potato rot and the Colorado potato beetle.

Wisconsin Station, Bulletin No. 29, October, 1891 (pp. 18).

CREAMING EXPERIMENTS, S. M. BABCOCK, PH. D. (pp. 3–18).—"The chief object in undertaking the tests described in this bulletin was to compare the efficiency of the deep setting and centrifugal methods with different samples of milk. Incidentally the effect of delay in setting, the use of ice, and some other questions have been studied."

Trials at the station of the Cooley and the "shotgun" cans, both deep-setting cans, the cream being removed from the top of the cans by means of a conical dipper in the latter case, "showed no material difference in the efficiency of the two methods if the skimming was carefully done and the same amount of cream was taken in each case. More care, however, appears to be necessary in skimming the shotgun can, and I believe in general practice the losses with this can are greater than with the Cooley can."

With reference to the amount of skim milk that should be left with the cream in skimming Cooley cans, trials were made in which the skim milk was drawn off to within 2 inches, 1 inch, and ½ inch of the cream line, samples of the skim milk being taken for analysis in each case. Calculated to 100 pounds of milk set, the losses of fat in the skim milk were as follows:

	Pounds.
Skimmed to within 2 inches of cream line	0.213
Skimmed to within 1 inch of cream line	0.238
Skimmed to within ½ inch of cream line	0.338

Assuming the amount of buttermilk to be equal to the difference between the total amount of cream obtained and the fat contained in the cream, and that the buttermilk contained 0.3 per cent of fat, a calculation is made of the total amount of fat lost per 100 pounds of milk in the skim milk and buttermilk together.

"This indicates that the loss is practically the same whether 1 or 2 inches of skim milk are left with the cream. There is, however, a very material increase in the loss when another half inch of skim milk is drawn off."

Influence of character of milk upon efficiency of creaming (pp. 6–11).—The cows of the station herd were divided into five groups of from four to six each on the basis of the fat content of their milk. "The cows in all of these lots were treated alike, receiving the same food and care." The milk from alternate milkings of each lot was creamed by setting in Cooley cans, and that of the other milkings by the Baby Separator No. 2.

[Where the Cooley cans were used] the milk was set in ice water as soon as possible after milking, and skimmed after standing from 15 to 24 hours, all of the lots at the same milking being treated as nearly alike as possible. They were skimmed to within 2 inches of the cream line. * * *

[Where the separator was used] the milk was in some cases separated immediately after milking, while it was still warm; in other cases it was allowed to stand 2 or 3 hours before skimming. Whenever the milk had cooled below 80° F. it was warmed to between 80° and 90° before separation.

Ten trials were made with the milk from each lot by the Cooley system and seven by the separator. Fat determinations were made in the skim milk from every trial. The maximum, minimum, and average of these results are tabulated. The calculated loss of fat in the skim milk per 100 pounds of milk set is given as follows:

Loss of fat in skim milk per 100 pounds of milk set.

	Fat in whole milk; average.	Cooley system.			Baby Separator No. 2.		
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.
	Per cent.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Lot 1	5.53	0.102	0.063	0.080	0.087	0.083	0.084
Lot 2	5.22	0.311	0.080	0.193	0.088	0.081	0.083
Lot 3	4.52	0.239	0.137	0.176	0.087	0.082	0.084
Lot 4	4.19	0.237	0.137	0.189	0.088	0.082	0.084
Lot 5	3.86	0.452	0.176	0.324	0.166	0.083	0.103

Estimating the fat in the buttermilk in the manner described above, the average total loss of fat in buttermilk and skim milk per 100 pounds of milk set is calculated for the two systems as follows:

Comparative losses of fat per 100 pounds of milk creamed by centrifuge and deep setting.

	Lot 1.	Lot 2.	Lot 3.	Lot 4.	Lot 5.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Deep setting	0.148	0.257	0.239	0.245	0.382
Centrifuge	0.107	0.109	0.110	0.110	0.129
Difference in favor of centrifuge	0.041	0.148	0.129	0.135	0.253

When the Baby Separator was first tried by us the cream screw was so adjusted that the cream contained over 30 per cent of fat. This cream, when ripened, was too thick to churn well, the buttermilk containing from 0.5 to 1 per cent of fat. By diluting this cream with about one fifth its volume of water, the fat in the buttermilk was reduced to about 0.2 per cent and in some cases as low as 0.15 per cent. This improvement I believe to be due entirely to having reduced the consistency of the cream to a point where it was uniformly churned. This is closer work than is usual with cream from deep setting, and warrants the conclusion that centrifugal cream, containing about 25 per cent of fat, will churn more efficiently than that from deep setting, which contains less than 20 per cent.

Delayed setting (pp. 11–17).

The following trials were undertaken to determine whether the creaming of different samples of milk would be similarly affected by delay in setting when deep setting is used. The tests were made with milk from the same groups of cows used in the preceding experiment. In each trial the milk from each group of cows was mixed and divided, one half of it being set immediately in ice water, the other half being set in the same tank after standing in the open air for periods ranging from 15 minutes to 3 hours. The delayed milk was mixed just before being put into the tank. The samples were skimmed in the order in which they were placed in the tank, both the delayed and immediate setting being allowed the same time—usually 12 hours—for creaming. In most cases the milk was drawn off to within 2 inches of the cream line, although some milk was skimmed to within 1 inch. All comparative trials were skimmed in the same way. [Eighteen comparative tests were made with milk from each lot. The results are tabulated.] * * *

Although on the whole these trials show considerable loss by delayed setting, their most interesting feature is the influence which delay has upon the creaming with different kinds of milk.

The loss by delay with milk from lot 3 was practically nothing; with lots 4 and 5 the loss was also very small, while with lots 1 and 2 it was very large, being largest of all with lot 2. The loss of fat from delay appears to be independent of the amount of fat in the milk, although as a rule it is somewhat larger in the rich milk than in the poor milk. * * *

If the loss of fat in the buttermilk be considered, the difference in favor of immediate setting would be still more marked on account of the increased quantity of buttermilk from the delayed portions. * * *

Tests in which the milk from each lot of cows was divided as before, one half being set immediately after milking, the other half after 30 minutes' delay, the milk being kept warm until put into the tank, [indicated] that the efficiency of the creaming by delayed setting is not materially improved by keeping the milk warm.

The results of similar experiments at the Maine Station, reported in the Annual Report of that station for 1890, part II (see Experiment

Station Record, vol. III, p. 22), and the New York Cornell Station, reported in Bulletin No. 29 of that station (see Experiment Station Record, vol. III, p. 231), are cited. These results showed practically no loss due to delayed setting. The results with lots 3, 4, and 5 are in accord with these, but those with lots 1 and 2 are at variance with them.

The difference in the creaming between the delayed and immediate setting is shown in an entirely independent way by the quantity of cream obtained in the two cases. It is a general rule that where the separation of cream is retarded in any way it will occupy more space than where it is not retarded. In the 99 trials made in these tests 70 show more cream from the delayed portions, 16 have the same amount upon both, and 13 show more upon immediate setting.

In lots 1 and 2, where the most difference was found, every trial showed a larger volume of cream upon the delayed portion. In these two lots also every trial showed more fat in the skim milk from the delayed portion. In the 99 trials 82 gave more loss from the delayed, 7 gave the same, and 10 gave more in the immediate setting. Lot 4 showed the least difference and lot 2 the most.

Is the use of ice profitable in deep setting? (p. 17).—Numerous trials were made with herd milk set as nearly as possible under the same conditions, except that the temperature of the water in the tank varied from 35° to 58° F. The milk was skimmed after 11 to 12 hours. The losses of fat in the skim milk per 100 pounds of milk set at the different temperatures of setting were as follows:

	Pounds.
Ice, 35° to 45° F	0.232
No ice, 48° F	0.297
No ice, 54° to 56° F	0.746
No ice, 58° F	0.949

I am confident that in most cases [the loss of fat where no ice is used is] from ½ to 1 pound more per 100 pounds of milk than where sufficient ice is used to maintain the temperature below 50° F. With a herd of ten average cows this makes a difference in favor of ice of from 20 to 40 cents per day, if butter sells for 20 cents per pound. In most localities this would cover the necessary expense for ice and leave a large margin for profit.

Conclusions (p. 18).—The results indicated by the above experiments are summed up by the author as follows:

(1) In skimming by the Cooley system the siphon should be set so as to leave at least 1 inch of skim milk with the cream.

(2) The efficiency of creaming by deep setting is greatly influenced by the character of the herd, the milk from some herds creaming very close, while that from other herds, under the same conditions, creams poorly. This difference may amount to as much as 1 pound of butter per 100 pounds of milk.

(3) Delay in setting may cause a considerable loss with the milk from some herds and scarcely any with that of others. To avoid the possibility of such loss it is recommended that milk be set as soon as possible after milking.

(4) Deep setting without ice under the most favorable conditions results in considerable loss, and where the temperature of the water used is not lower than 50° F. the loss is excessive, reaching in some cases as much as 25 per cent of the total fat in the milk.

(5) The centrifugal system of separating cream overcomes all of these difficulties, giving an efficient creaming with milk from all sources, either directly after milking or after standing several hours.

(6) The Baby Separator No. 2 may be used with advantage with herds of from ten to twenty cows.

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

Report on the Use of Maize (Indian Corn) in Europe (pp. 36).—This includes articles on The Introduction of Maize into Europe, by C. J. Murphy; The Food Value of Maize, by H. W. Wiley; and The Indian Corn Industry in the United States, by B. W. Snow. Mr. Murphy gives an account of the efforts made by him, for the most part as a special agent of this Department, to increase the demand for our corn in foreign countries. The following statements are taken from his report:

The exports of our maize or Indian corn for the past 10 years may be said to have averaged about 4 per cent of the entire crop. The United Kingdom, France, Germany, Belgium, Holland, and Denmark rank as our best customers for the grain, while Spain and Norway and Sweden take a small quantity. Except an insignificant amount, exported corn is chiefly used as food for animals, distillery purposes, and starch making. The only form of corn as human food at all known abroad is corn starch, which is sold principally in the British Isles under the name of corn flour. * * *

Stated in a few words, the way to increase the export of it as human food, and that which I have as far as possible adopted, is to practically illustrate abroad its value by ocular demonstrations; cooking it in presence of the public; serving it free or at nominal prices; distributing literature giving full description of the grain, price as compared with wheat, oatmeal, and potatoes, etc.; and enlisting public interest through representative bodies and personages and the general and agricultural press. The effort, extensively put forth and persisted in, can not fail to have beneficial results. It would assist our farmers in an entirely practical manner, with benefits certain and positive, raising the price of every bushel of corn gathered by the American husbandman. * * *

In order to obtain the best results, corn intended for human food in foreign countries should be kiln-dried before shipment. When that is done it keeps for a long time in prime order. European millers are not familiar with, or if so do not practice the proper methods of grinding corn, consequently an inferior meal is produced, which strongly militates against its introduction on the table. Kiln-dried home-ground meal is the first essential in order to make an effective and creditable display of the nutritive qualities and general excellence of the grain. * * *

American canned goods of all kinds are largely sold in Europe, but it is a sad fact that the delicious canned corn is rarely seen. This should not be; there is no reason why it should not figure on the table of the European as well as on that of the American. The demand that should exist for it would mean hundreds of thousands of dollars yearly to the proprietors and workers of our extensive canneries. * * *

The condition of things on the continent is favorable to the introduction of a new cereal food and a new source of supply. I am, moreover, extremely hopeful of securing favorable consideration on the part of the army officials of a bread to be

composed half of corn meal and half of rye meal, for use as army rations, in place of a bread made of rye exclusively. I have already caused several loaves of such bread to be baked, and have submitted them to various persons, among them some Government officials, and I may state that in every case where tested this bread has received the highest commendation. Its cost will be much less than a bread consisting exclusively of rye, and I am satisfied that high medical authorities will substantiate its great value as a food.

DIVISION OF VEGETABLE PATHOLOGY.

Bulletin No. 1.

Peach yellows and peach rosette, E. F. Smith (pp. 65, plates 38).—The first part of this report is on investigations and experiments during the past 3 years with reference to the communicability of peach yellows. The destructive nature of peach yellows and the characteristics of the disease are described. An account is given of inoculation experiments on a large number of trees in different localities. On the theory that peach yellows is at first a local disease, experiments in cutting away diseased portions of trees were made. "The results varied considerably, but in no case did the removal of affected parts stop the progress of the disease." Observations and experiments were also made with reference to the immunity of trees from this disease under certain conditions. The facts which the author regards as established by these investigations are as follows:

(1) The disease is contagious.

(2) It may be conveyed by seemingly healthy buds when these are taken from diseased trees.

(3) Only a very small amount of infective material is necessary, provided it be in the form of living cells, which can be induced to unite with the actively growing tissues of the tree.

(4) The disease has a longer period of incubation than we have been accustomed to suppose.

(5) The death of the entire tree occurs, ordinarily, only after a very considerable period, *i. e.* several years.

[The hypotheses rendered probable are as follows:]

(1) The whole tree is affected when symptoms appear in any part of it.

(2) In some cases—perhaps in many—the period of incubation, *i. e.* the time between the insertion of a diseased bud and the appearance of the disease, is longer than any yet clearly established.

(3) The disease is also communicated to budded trees in some other way than by bud inoculation. This is probable in case of many young trees, and is almost certain in case of old trees.

(4) The trees are not infected through the blossoms. This is inferred from the result of the excisions, and from the fact that in some cases the disease appears to develop between fall and spring, and to stimulate the blossoms themselves to an unnaturally early development.

(5) Since diseased trees have been shown to be very full of infectious matter, it must be that, for unknown reasons, much of this fails to find an immediate entrance into healthy trees, otherwise the peach would soon disappear entirely.

Three special lines of inquiry are now under consideration and will receive undivided attention as soon as the laborious experiments with fertilizers have been completed. These are as follows:

(1) The period of incubation of the disease prior to its first appearance, *i. e.* the greatest length of time a tree may be affected before it shows any symptoms of yellows.

(2) The exact nature of the contagion.

(3) Its method of spread other than by bud inoculation.

The second part of this report is devoted to peach rosette, a disease prevalent in Georgia, which was at first thought to be a variety of peach yellows. The characteristics of the disease are described and an account is given of inoculation experiments.

The following summary is taken from the bulletin:

(1) The rosette, as now understood, differs from peach yellows in the following particulars:

(*a*) The more tufted character and somewhat different appearance of the diseased growths.

(*b*) The much greater tendency of these compactly tufted growths to develop in early spring from winter buds and to appear all over the tree.

(*c*) A smaller tendency to develop sprouts upon the trunk and main limbs.

(*d*) The absence of premature fruit.

(*e*) The general early fall of leaves and fruit on affected trees, the fruit being small, yellowish green, and more or less shriveled and gummy.

(*f*) Gummosis of the roots.

(*g*) The occurrence of the disease in plums.

(*h*) The much more speedy destruction of affected trees.

(2) The disease is virulently contagious, and it is probable that something might be done toward checking its increase by the prompt destruction of all affected trees. This should be done in early spring, as soon as the disease appears and before the leaves begin to fall.

(3) The disease may exist for a short time in part of a tree without being in the rest of it, but it soon involves the entire tree. In other words, it would seem that the cause of the disease must enter the tree at some particular point or points and be carried gradually to all parts through the circulation.

(4) As in peach yellows, the admitted fact that neighboring trees are not always the next to take the disease is no argument against its communicable nature.

(5) This disease has gained a strong foothold and is on the increase, especially in that part of Georgia known geologically as the Archæan.

(6) If Georgia peach growers would save their orchards and maintain the successful cultivation of the peach, the necessity for prompt and concerted action appears to be very great.

WEATHER BUREAU.

MONTHLY WEATHER REVIEW, VOL. XIX, NOS. 7, 8, AND 9, JULY, AUGUST, AND SEPTEMBER, 1891 (pp. 155–232).—The origin of the data from which this publication is prepared is thus described in the introduction of the July number, though the number of observers varies somewhat from month to month:

This review is based on reports for July, 1891, from 2,402 regular and voluntary observers. These reports are classified as follows: One hundred and sixty-three reports from the Weather Bureau stations; 118 reports from United States Army post surgeons; 1,545 monthly reports from State weather service and voluntary observers; 33 reports from Canadian stations; 179 reports through the Central Pacific Railway Company; 364 marine reports through the coöperation of the Hydrographic Office,

Navy Department; marine reports through the *New York Herald* weather service; monthly reports from the local services of Alabama, Arkansas, Colorado, Illinois, Indiana, Iowa weather and crop service, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, Nevada, New England, New Jersey, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, Washington, and Wisconsin; and international simultaneous observations. Trustworthy newspaper extracts and special reports have also been used.

Each number includes summarized statements for the month regarding the characteristics of the weather, atmospheric pressure, North Atlantic storms, temperature of the air, precipitation, winds, inland navigation, atmospheric electricity, miscellaneous phenomena such as drouth and prairie and forest fires, verifications of forecasts, and extracts and summaries from reports of the several State weather services. There are also original articles and meteorological tables and charts.

In the July number an article on Some Experiments in Atmospheric Electricity, by A. McAdie, contains the following brief description of a new type of electrometer to be used in taking observations of the potential of the air:

The instrument is essentially an enlarged quadrant electrometer, with the parts so arranged as to be convenient of access, and instead of the four quadrants, single needle, and bifilar suspension we use some eighty large quadrants, a needle with twenty blades, and a very fine platinum wire for suspension and directive force. The present instrument has its defects—plenty of them, no doubt; but besides the great advantages of the mechanically registered curve, recording the actual motion of the needle, is the greater one of seeing and getting at any moment the potential of the air—not having to wait 24 hours therefor, and the ability to compare directly these curves with the curves of atmospheric pressure, temperature, humidity, wind direction, wind velocity, cloudiness, etc., as given by self-recording instruments.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

The chemical distinction between true albuminoids, albumose, and peptone, M. Flaum (*Chem. Ztg., 15 (1891), rep., p. 298*).—The author explains that through the studies of Kühne, Chittenden, and Neumeister that part of the science of chemistry pertaining to the albuminoid bodies has reached a new phase. The albumoses and peptones are products of the true albuminoids, and are formed both in the course of the pepsin-pancreas digestion and by the action of diluted acids. The first product is acid albumin, which by long-continued digestion goes over to albumose. The albumoses change by further action of enzymes or diluted acids into the different peptones.

Among the reagents for recognizing albuminoid materials are several which permit of discrimination between albumen, albumose, and peptone. The characteristic precipitates obtained with nitric acid, acetic acid and common salt, and acetic acid and potassium ferrocyanide do not disappear on heating if they are caused by true albuminoids; if caused by albumose the precipitate is dissolved by heating and reappears on cooling. The peptones give no precipitate with those reagents. The biuret reaction is a commonly used reaction, but it shows the red color in the presence of peptones. For the purpose of distinguishing between and separating albumose and peptone, ammonium sulphate is recommended, which precipitates all albumose but leaves the peptones in solution. The reagent in form of a fine powder is added to the solution to be treated to the point of saturation. The complete precipitation of albumose requires about 24 hours. Peptone, according to Kühne, possesses no nutritive value. The animal organism can not use it to supply the requisite amount of albuminoids in the body. Albumose, on the contrary, is completely regenerated to albuminoids, and can nourish the organism as well as true albuminoids. It is therefore in reality not the peptone but the albumose that is wanted in the so-called peptone preparations offered for sale.

The application of the centrifuge in analytical and microscopic work, W. Thörner (*Chem. Ztg., 15 (1891), pp. 1201–1203*).—The author mentions the use of the centrifuge in milk analyses for determining fat, and claims that it is adaptable to analysis of flour, ground feeding stuffs, butter, etc. In his tests the author used a Victoria centrifuge capable of 6,000 to 7,000 revolutions per minute.

Examination of flour, meal, etc.—For tests of these materials a tube of about 15 c. c. capacity is used, similar in shape to those used for testing milk, but reversed, the neck being closed at the outer end and graduated to fiftieths of a cubic centimeter. When 1 gram each of different kinds of meal was placed in the tubes nearly filled with water, shaken until the lumps were all broken, and then whirled in the centrifuge at the rate of 2,000 to 2,500 revolutions per minute for exactly 5 minutes, the space occupied by the meal in the neck (bottom) of the tube was found to depend upon the fineness and specific gravity of the particles, being larger the lighter and larger the particles of meal. Thus in a test of a number of different kinds of meal and starch the space occupied by 1 gram of material after whirling 5 minutes ranged from 12.6 (rice starch) to 30 tenths of a cubic centimeter. Alcohol and ether were tried in place of water, but the latter was found more satisfactory. It is claimed that adulterations of bran, flour, and the like may be detected by this means and quantitatively estimated, at least approximately, and the results of numerous tests in this direction are reported. The microscope is recommended as a valuable supplement in recognizing the character of the adulterants.

Butter analysis.—The tube described above is also used for testing butter. To save time the sample of butter is measured instead of weighed. For this purpose a thin piece of glass tubing, fitting into the opening of the test tube and of such length as to contain 10 c. c., is used. This measuring cylinder is filled by pressing it into the butter, and the butter is removed from the ends by passing a glass plate over them. The cylinder is then wiped and placed in the wide part of the test tube which has been heating in the water bath. The butter is quickly melted and runs down into the tube. The measuring cylinder is then removed and the tube is whirled in the centrifuge running at about 2,000 revolutions per minute for 2 to 3 minutes. At the end of this operation two layers are usually plainly perceptible in the aqueous portion, which is sharply divided from the layer of liquid fat above it. The lower aqueous layer is nearly clear and contains crystals of salt, mineral substances, etc.; the upper layer consists principally of casein suspended in water. The relation of these two aqueous layers to each other is said to be very variable. Their sum represents the buttermilk content of the sample. Ten minutes is said to be sufficient for the test.

As the butter fat so separated is in a nearly pure condition, it may be saponified to get the fatty acids and the index of refraction taken. For the saponification a tube is used, which is similar to the one used in most of the rapid milk tests, except that the neck widens above the graduated part into a bulb of about a third the capacity of that below. The narrow part between the two bulbs of 1.4 to 1.5 c. c. capacity is graduated to fiftieths of a cubic centimeter. One c. c. of the butter fat is measured out into the tube by means of a pipette at a temperature of 100° C., butter fat, pipette, and tube being previously heated together in a

boiling water bath to bring them to this temperature. To this 1 c. c. of fat, 4 c. c. of alcoholic potash solution (prepared by dissolving 160 grams potassium hydrate in as little hot water as possible and then diluting to 1 liter with alcohol), and a couple of pieces of pumice stone are added and the tube hung in a water bath. In from 10 to 15 minutes the saponification is completed and the alcohol evaporated. The saponified fat is dissolved in about 10 c. c. of hot water and the fatty acids separated by adding 5 c. c. sulphuric acid (1 : 4), heating in a water bath, adding hot water sufficient to bring the dissolved fatty acids up into the graduated part of the tube, and then whirling in the centrifuge for 2 minutes. The volume is then read off at 100° C. The operation is said to require about half an hour. In numerous determinations by the author the fatty acids constituted in butter 90 to 91 per cent, in margarine 94 to 95 per cent, and in other fats 95 to 97 per cent of the fat taken. Finally, it is proposed to determine the index of refraction of the melted fat by means of a Pulfrich refractometer.

The author claims that in a short time and without taking any weights, valuable data for judging of the character of butter are secured by the method just described.

Concerning the direct absorption of ammonium salts by certain plants, A. B. Griffiths (*Chem. News, 64 (1891), p. 147*).—The following experiments are in confirmation of results previously reached by Müntz, who found that the roots of certain plants (beans, barley, hemp, and corn) were capable of absorbing ammonium salts without the latter being first converted into nitrates.

Young bean plantlets were immersed in a solution of copper sulphate for 30 minutes to destroy any nitrifying organisms that might be present, then washed in sterilized distilled water, and the roots placed in a sterilized culture solution composed as follows: 1 liter distilled water, 1 gram potassium chloride, 0.03 gram ferrous carbonate, and 0.5 gram each of sodium chloride, calcium sulphate, magnesium sulphate, tricalcic phosphate, and ammonium sulphate. Only pure chemicals were used. The cultures with the plantlets were placed under sterilized bell glasses and supplied with air filtered through cotton wool to sterilize it. The plants grew well for 4 weeks, although the culture medium contained nitrogen only as ammonium sulphate whose nitrification was guarded against. Not a trace of nitric nitrogen could be detected in any of the twenty-four culture solutions at the end of this time. The percentage of ammonium sulphate in the solution, which was 0.05 at the beginning, was found to be diminished to 0.027 at the end. During the growth of the plants no nodules were formed on the roots, indicating that no nitrogen was derived from the air.

Although in nature the ammonium salts may, as a rule, be changed to nitrates before they are taken up by plants, these experiments seem to show that under certain circumstances unchanged ammonium salts may be directly appropriated by plants.

New experiments in soil inoculation, Schmitter (*Wochensch. der pomm. ökon. Ges., 1891, pp. 251, 252*).—These experiments were made on the fields of the Agricultural Institute of the Leipsic University. Three plats (size not given) were selected from different parts of the field. Plat 1 was located in a garden; plat 2 was among the experimental plats; and plat 3 was from a meadow long in grass, on which no papilionaceous plants had been grown, the object being to secure a piece of land which had long been uncultivated and free from leguminous growth. April 15 half of each of the plats was manured at the rate of 356 pounds superphosphate and 436 pounds of potash-magnesium sulphate per acre. Each plat was then divided crosswise into eight strips, each 1 meter wide, and separated from each other by intervening strips. Yellow lupine was sown on all the plats, and on strips 2, 4, 6, and 8 of each plat fresh lupine soil, rich in bacteria, was sown at the rate of from 1,800 pounds to 9 tons per acre. Lupine had not previously been grown on any of the plats and all were very much reduced in fertility.

The lupines made a rather weak growth on all the plats till the last of June, when a more luxuriant growth commenced. On plats 1 and 2 this growth seemed to be equal on all the strips, and no difference was perceptible between the growth on the inoculated and the uninoculated strips up to the time of harvest. As compared with previous observations, the root tubercles were very late in forming and scanty in number. The number of tubercles on the roots of plants from different strips was counted and found to average about the same for all the strips of plats 1 and 2.

On plat 3, however, the case was different. At first there was no perceptible difference between the inoculated and the uninoculated strips, but about the middle of July the inoculated strips commenced to gain and soon were distinguishable from the uninoculated strips even at a distance. When the tubercles were counted more and better-developed tubercles were found on the plants from inoculated strips.

The plants on all three plats were harvested September 17 and dried under cover. Measurements were made on ten representative plants from each strip, and the weights taken of the air-dry plants (hay and seeds separately). The results on plats 1 and 2 showed no advantage from inoculating the soil. The results on plat 3 are given as follows:

Results on inoculated and uninoculated strips of meadow land.

	Yield of lupine.		Length of root.*	Height of plant.	No. of root tubercles per plant.
	Hay.	Seeds.			
	Kg.	*Kg.*	*Cm.*	*Cm.*	
Strip No. 1	4,700	2,850	17.5	87.8	4
2 inoculated	4,780	2,950	20.4	95.8	7
3	2,300	2,350	20.4	98.0	5
4 inoculated	4,700	2,650	21.1	100.5	12
5	4,650	2,400	17.9	96.9	4
6 inoculated	4,850	2,800	19.6	99.3	10
7	4,750	2,550	20.4	91.5	3
8 inoculated	4,850	2,800	23.0	102.0	11
Total yield from inoculated strips	19,180	11,200			
Total yield from uninoculated strips	16,400	10,100			

* Length of longest root below the surface.

In the case of plat 3, therefore, the yield, production of tubercles, and depth to which the roots reached, as well as the general growth of the plants, were favorable to the inoculation.

Composition of drainage waters from bare and cultivated soils, P. P. Dehérain (*Ann. Agron., 17 (1891), pp. 49–82; abs. in Forsch. auf d. Geb. d. agr. Physik, 14 (1891), pp. 277–281*).—In continuation of previous research, experiments are here reported on the loss of nitrogen by drainage under varying conditions and with different soils.

Uncultivated soils.—The amount of nitrates appearing in the drainage waters from different soils from March 1 to November 7 was found to be quite variable, and these variations seemed not to be attributable to differences in rainfall. The amount of nitrates washed out was much the smallest in the case of the soils richer in organic matter (humus), which Warington and Winogradsky have shown to be unfavorable to nitrification.

Soils manured with ammonium sulphate.—A soil was used which had been exhausted by cultivation. Pots filled with this (30 kg. each) received 12 grams of ammonium sulphate (700 pounds per acre) in the fall of 1889 or received no fertilizer. From January 6 to July 15, 1890, the unmanured soil gave off 646 mg. of nitrogen as nitrates in the drainage water, and the manured 2,611 mg. The change of the ammonium salt to nitrate progressed far more rapidly during the warm season than during the colder, for while only 572 mg. of nitrogen were washed out by the drainage water from January 6 to March 21, 2,039 mg. were removed between June 3 and July 15. In the 8 months from November, 1889, to July, 1890, the larger part, although not the whole, of the nitrogen applied in the ammonium sulphates was removed by the drainage water.

Cultivated soils.—Oats, hemp, rye grass, peas, and clover were grown in pots (1) in good soil without fertilizer and (2) in worn-out soil without fertilizer, and with dressings of mixed fertilizer containing 0.32 gram of nitrogen per pot; an extract of barnyard manure containing 16.71 grams of organic matter and 1.47 grams of nitrogen per pot; and the two combined, furnishing 1.79 grams of nitrogen per pot.

The pots were set in the air above ground. These conditions, as the author remarks, were artificial in so far as the heating of the pots on the sides made the soil in them warmer and dryer than that in the field. The higher temperature naturally conduced to a more intensive nitrification, while the increased dryness of the soil had just the reverse effect. Taking the results as they are, however, the amount of nitrates in the drainage water seemed to depend upon the kind of plants grown. The indications are that the loss of nitrogen as nitrates by drainage is very much less with graminaceous than with leguminous plants. Thus, while, roughly speaking, 26 mg. of nitrate nitrogen per pot was lost from the oat and rye grass cultures, 200 mg. per pot was lost from the pea and clover cultures. On the other hand the quantity of drainage

from the former was considerably less than from the latter. The author would explain this excessive loss of nitrates from the leguminous cultures by inability of these plants to take up the nitrates from the soil in the same degree as other plants. With reference to the hemp, the indications were that this plant was only able to appropriate the nitrates when organic nitrogenous matter was present, *i. e.* when the barnyard manure extract was applied with the nitrate. In its absence the plants seemed unable to prevent the washing out of considerable quantities of nitrates.

Fallow cultures.—To prevent the loss of nitrogen from the soil by drainage after harvest, it was proposed to sow rapidly growing crops on fields where beets, corn, hemp, oats, and peas had been raised, and later to plow these second crops under. Although the season was dry and the crops winterkilled, prematurely terminating the experiment, the advantage of the aftergrowth was very apparent. In November, before the frost, the drainage water washed out on an average 9.6 pounds of nitrogen as nitrates from the bare and 0.36 pounds from the cultivated soil per acre. The case was similar where perennials (rye grass and clover) were raised.

The food value of brushwood, A. Stutzer (*Deut. landw. Presse, 1891, p. 943*).—Attention was called last year by Ramenn and von Jena, in a pamphlet published by them, to the fact that the brushwood or the younger twigs from trimming out the tops of trees (*Holzreisig*), possessed a value for feeding purposes, and might be used to supplement the food supply when crops were poor. In order to prepare the material for feeding it was to be crushed and broken up, 1 per cent of malt added, hot distillery swill or something of the kind poured over it, and then allowed to work for 1 to 3 days.

The material used by the author for analysis was obtained by treating twigs gathered in winter in the above manner. The analyses follow of fodder made from beach, pine, alder, and common locust:

	Beach.	Pine.	Alder.	Locust.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	10.12	7.51	6.87	6.98
Crude protein	4.50	5.19	7.12	7.94
Amides and digestible albuminoids	1.25	2.13	3.56	5.06
Undigestible protein	3.25	3.06	3.56	2.88
Coefficient of digestibility of crude protein	27.80	40.90	50.00	63.80

The locust not only contains the largest percentage of protein, but the protein is the most digestible.

Studies of the changes in potato tubers in keeping, E. Wollny (*Forsch. auf. d. Geb. d. agr. Physik, 14, pp. 286–302*).—It is a familiar fact that potatoes suffer a loss in weight by keeping, on the one hand by the evaporation of water and on the other hand through the

changes occasioned by the process of respiration in the organic matter, especially the nitrogen-free extract. These losses and changes have been previously studied by other investigators, and in addition to a description of his own experiments, the author briefly reviews the investigations by Nobbe,* Müller-Thurgau, and others.

Nobbe studied the changes both in weight and in chemical composition under varying conditions of temperature, moisture, light, etc. Briefly, his experiments indicated that the controlling factors in determining the loss in weight by keeping were first of all heat (temperature), and next the state of moisture of the air, heat increasing and moisture rather diminishing it, and that light had no perceptible effect on the loss in weight. Measurements of the water and carbonic acid given off indicated the former to be from three to four times that of the latter. The amount of carbonic acid given off seemed to be quite constant, but the transpiration of water increased in March to nearly twice the former amount. The per cent of starch increased in every instance where the tubers were kept at a high temperature (25° to 35° C.). The starch content slightly decreased where the tubers were kept moist and cold, and remained practically unchanged when kept dry and cold.

Nobbe's experiments were made entirely under artifical conditions, and his observations were confined to a small number of tubers. The present studies were on a much larger scale than those by Nobbe, and were confined to the changes in weight and certain outward appearances of the tubers. Of each of 12 different varieties of potatoes, 100 tubers were selected at the time of digging (early in October), brushed, weighed, and placed in lead cylinders in a moderately dark, deep, dry cellar, where the temperature ranged from 6° to 11° C. From October to April the tubers were weighed on the 1st and 15th of each month; after April 1 weights were taken only on the 1st of each month. The data secured indicate that under the conditions of the experiment the losses in weight were greatest directly after digging, and decreased from then till the 1st of March, when they commenced to increase. The average percentage losses of the 12 varieties from month to month were as follows: October 2.02 per cent, November 1.18, December 0.50, January 0.50, February 0.81, March 0.41, April 0.50.

In the case of each variety the loss in February was larger than in the month preceding or following, being in many cases doubled. The loss of weight during the colder period up to the 1st of May was much lower than during the following summer. The former loss aggregated on an average 6.17 per cent of the original weight, and the latter (May to October) 21.57 per cent.

The difference noticed in the losses of the different varieties did not seem to bear any fixed relation either to the size of the tubers or to the

* Landw. Vers. Stat., 7 (1865), pp. 452–461.

earliness or lateness of the variety (duration of the characteristic period of growth). Thus the total percentage loss from October to May 1 varied with the 3 early varieties from 4.87 to 8.48; with the 5 medium-early varieties from 4.55 to 6.78, and with the 4 later varieties from 5.71 to 7.28 per cent. Since, according to Nobbe, about three fourths of the loss may be attributed to loss of water and only about one fourth to the respiration, the above losses would indicate a loss of only 1.2 to 2.1 per cent of organic matter. These losses by keeping are believed to be lower than are usually assumed and lower than those observed by Nobbe.

The author refers to the two important factors in determining the loss, *i. e.* dryness and temperature, the last of which was studied by Müller-Thurgau,* and he gives a brief résumé of Müller's observations. According to Müller three distinct processes go on in potato tubers, namely, respiration, sugar formation, and retrograde starch formation. It is explained that the respiratory process takes place in the living protoplasm of the cells and consists of an oxidation of certain organic substances (sugar, etc.) through the atmospheric oxygen, the products of the process being carbonic acid and water. The intensity of the process depends upon certain conditions, as age of the tubers, temperature, quantity of material present which is capable of supporting the process, etc. Müller found that the process was more energetic the more sugar the protoplasm had at its disposal and the higher the temperature.

The importance of the second process—the sugar formation—is readily seen from the dependence of the respiratory process upon it. The sugars formed in the tubers are cane sugar and glucose, the larger amount being of the latter. This formation of sugar is believed to be from the starch by means of a ferment, but this ferment can not be diastase, since, according to the author, it does not occur in the tubers, and moreover from starch diastase forms dextrin and maltose. Temperature has a greater influence on the respiratory process than on the formation of sugar, so that at lower temperature more sugar is produced than is oxidized, and so accumulates. This fact explains the sweet taste of frozen potatoes, for while scarcely any respiration takes place at $-1°$ to $-2°$ C., the sugar formation is only slightly abated at this low temperature. But the sugar formation is not accelerated by increased temperature in the same proportion as the respiration is, so that it follows that the amount of sugar in potatoes depends upon the temperature at which they have been kept.

The retrograde starch formation, or the re-formation of starch from sugar, takes place when potatoes which have become sweet are subjected to a warm temperature for a time. According to Müller's experiments

* Bot. Centralbl., 19 (1882), No. 2; Landw. Jahrb., 1882, pp. 751–828, and 1885, pp. 851–912.

the following amounts of sugar were used or stored up per kilogram of tubers in an hour, at different temperatures:

	Temperature, C.					
	0°.	3°.	6°.	10°.	15°.	20°.
Sugar used:	*Mg.*	*Mg.*	*Mg.*	*Mg.*	*Mg.*	*Mg.*
In respiration	2.3	2.8	3.5	4.5	6.5	9.5
For starch formation	1.7	20.8	25.8	31.3	32.8	34.5
Sugar stored up	28.0	9.0	4.3	......	......	......

These figures point to 0°–10° C. (32°–50° F.) as the most rational temperature for keeping potatoes, since within these limits the respiration is low. As soon as the sprouts begin to grow the losses of organic matter increase in proportion to the growth of the sprouts. It is at this stage (after sprouting) that the greatest losses in the keeping of potatoes occur, and the shorter or longer time that elapses before sprouting and planting the greater or less the amount of reserve material in the tubers.

Feeding shorn and unshorn lambs in winter, T. Shaw and C. A. Zavitz (*Ontario Agr. College Expt. Station Bul. No. 68, October 26, 1891, pp. 8*).—This experiment was with twenty lambs, and lasted from January 6 to April 29, 1891. Ten of the lambs had been shorn the last of the previous November. The shorn lambs averaged 91.8 pounds, and the unshorn 101.85 pounds each in weight. Both lots were kept in a closed shed. Each lot received hay *ad libitum*, and definite amounts of unground oats and peas, bran, and roots, the amounts being the same for both lots. The total gains of the individual sheep in each lot varied widely, ranging with the unshorn sheep from 36 to 51 pounds, and with the shorn from 26 to 70 pounds. The total gains for the two lots were practically the same, being 426.5 pounds for the unshorn and 427.5 pounds for the shorn sheep. A calculation of the financial results, based on current prices, and valuing the lambs at 7 cents per pound at the close, shows the profit with the ten unshorn lambs to have been $26.44 and with the ten shorn lambs $30.14, but the latter includes $5.93 received for the wool shorn from the second lot, and no account is taken of the value of the wool on the unshorn lot.

Fattening lambs for the British market, T. Shaw and C. A. Zavitz (*Ontario Agr. College Expt. Station Bul. No. 69, November 2, 1891, pp. 7*).—Out of a lot of over 500 lambs purchased by the station 90 were selected for winter fattening. They were all shorn October 22 and 23, and October 24 the experiment commenced. From this time until November 21 they "were allowed to pasture on rape in the daytime when the weather was fine," and received in addition hay and grain composed of 7 parts by weight of oats, 1 part oat screenings, 3 parts peas, and 1 part bran. From November 21 until April 24, the

close of the experiment, they received hay, grain, and roots (sliced turnips). During the feeding the ninety lambs gained 4,513.5 pounds live weight, or 50 pounds per head. They were shipped to England, together with ten others, where they were sold for $1,061.08. The cost of transportation and sale of the lambs was $375.21. Reckoning oats at 34½ cents, peas at 52 cents, and turnips at 8 cents per bushel, bran at $14 and hay at $4.50 per ton, and making an allowance for the value of the manure, there was an apparent profit of $108.42. The cost of shipping "was considerably more than the average outlay, which experienced shippers put at from $2.50 to $3 per head. This arose in part from the smallness of the shipment. * * * It is confidently believed that the cost of transportation and sale will be much reduced in the next shipment. * * * It is the intention to repeat the experiment in the coming winter and spring."

Determination of casein in milk, J. Roux (*Moniteur Scientif.* (4), *5 pp. 478–482; abs. in Chem. Centralbl., 1891, part 1, p. 1091*).—The author uses the word casein to mean the total albuminoids of milk, as casein lacto-protein, milk albumen, etc. The method described is a modification of one previously proposed by Adams, the essential difference between the two consisting in the final precipitation of the casein freed from fat by alcohol and acetic acid in the Adams method, and by trichloracetic acid in the new method. The Adams method is said to give too low results, not insuring the complete precipitation of the casein. The method proposed is as follows: Ten c. c. of milk are extracted with 25 c. c. of the Adams mixture of ether, alcohol, and ammonia, the lower (aqueous) layer drawn off, the residue (solution of fat in ether) washed with water, and the washings added to the first aqueous portion, making the volume of the latter 40–50 c. c. This is gently shaken with 2 c. c. of a 50 per cent solution of trichloracetic acid, and the precipitated casein collected on a tared double filter. The precipitate is washed on the filter with 50 c. c. of water containing 1 c. c. of trichloracetic acid, and the filters dried to constant weight at 110° C. If the milk is sour (curdled) or unusually rich in casein, 10 c. c. are to be shaken first with 1 or 2 c. c. of 25 per cent ammonia and then with 25 c. c. of the Adams solution till the casein is all dissolved, and the solution then precipitated with 0.5–1 c. c. of trichloracetic acid, as given above. Since any peptones present would remain unprecipitated by the trichloracetic acid and pass into the filtrate, and as the filtrate from the casein precipitate gave no reaction for peptones with either the Esbach or the Tanret reagents, the author concludes that pure fresh milk does not contain peptones in any perceptible amount. It is mentioned casually that the presence of trichloracetic acid entirely prevents the reduction of Fehling's solution by milk sugar. The casein found indirectly by taking the difference between total solids and the sum of the fat, sugar, and ash, was invariably somewhat higher than that found by the direct method described above.

Composition of frozen and unfrozen diffusion chips, A. Stutzer, (*Deut. landw. Presse, 1891, p. 943*).—To observe the effect of freezing on the nutritive value of sugar beet diffusion chips, samples of severely frozen and of unfrozen material were taken from the same silo (a pit in the ground). The unfrozen chips contained 90.4 per cent of water and 0.6 per cent of ash; the frozen, 87.5 per cent of water and 1.2 per cent of ash. The water-free and ash-free material contained in 100 parts is as follows:

	Unfrozen.		Frozen.	
	Per cent.		*Per cent.*	
Crude fat	0.77		1.35	
Crude protein	12.06		10.45	
Crude cellulose	28.90	85.86	18.19	83.63
Nitrogen-free extract	56.96		65.44	
Acid	1.31		4.57	
	100		100	

The coefficient of digestibility of the protein was, unfrozen chips 86.3 per cent, frozen 70 per cent. The action of the frost rendered a part of the cellulose more easily soluble, increased the acid content, and diminished the digestibility of the protein. Furthermore, frozen chips did not keep as long, and greater losses of organic matter resulted from their keeping. In view of these losses the author deems it very desirable that the chips be dried at the factory before they are taken by the farmer. Since the Büttner and Meyer method has made this practicable, and the recent investigations of Maercker and Morgen* have demonstrated the high feeding value of dried diffusion chips, he expresses the hope that the financial consideration—the chief objection of the beet sugar manufacturers to fitting up with the Büttner and Meyer method—will be speedily overcome.

* Wesen u. Verwertung der getrockneten Diffusions-rückstande der Zuckerfabriken; Deut. landw. Presse, 1891, pp. 763 and 775.

TITLES OF ARTICLES IN RECENT FOREIGN PUBLICATIONS.

Three years' experiment in inoculating lupine (*Dreijährige Impfversuche mit Lupinen*), C. FRUWIRTH-MÖDLING.—*Deut. landw. Presse, 1892, No. 1, p. 6.*

Experiments in the inoculation of serradella and single-flowered vetch (*Vicia monantha*) (*Impfversuche mit Serradella und einblütiger Erve*), C. FRUWIRTH-MÖDLING.—*Deut. landw. Presse, 1892, No. 2, p. 14.*

The dependence of the assimilation of free nitrogen by plants on species, supply of plant food, and kind of soil (*Die Assimilation freien Stickstoff bei den Pflanzen in ihrer Abhängigkeit von Species, von Ernährungsverhältnissen, und von Bodenarten. Arbeiten aus dem pflanzenphysiologischen Institut der königlichen landwirtschaftlichen Hochschule in Berlin*), B. FRANK.—*Landw. Jahrb., 21 (1892), Heft 1 und 2, pp. 1–45.*

Contributions to the solution of the nitrogen question (*Beiträge zur Lösung der "Stickstofffrage"*), H. IMMENDORFF.—*Landw. Jahrb., 21 (1892), Heft 1 und 2, pp. 281–339.*

Transformation of albuminoids in the vegetable organism, IV (*Ueber den Eiweissumsatz im Pflanzenorganismus*), E. SCHULZE (Zurich).—*Landw. Jahrb., 21 (1892), Heft 1 und 2, pp. 105–130.*

The injurious action of aqueous solutions of copper sulphate and copper nitrate on soil and plants (*Ueber die schädigende Wirkung von kupfersulfat- und kupfernitrathaltigem Wasser auf Boden und Pflanzen*), EMIL HASELHOFF.—*Landw. Jahrb, 21 (1892), Heft 1 und 2, pp. 263–276.*

The adulteration of basic slag, BERNARD DYER.—*Analyst, 17, January, 1892, p. 4.*

Concerning the nitrogen-free constituents of vegetable feeding stuffs (*Ueber die stickstofffreien Bestandtheile der vegetablischen Futtermittel*, E. SCHULZE (Zurich).—*Landw. Jahrb., 21 (1892), Heft 1 und 2, pp. 79–103.*

Report of experiments made by the Royal Agricultural Academy of Poppelsdorf on the feeding value of brushwood (*Bericht über die an der königlichen landwirthschaftlichen Akademie zu Poppelsdorf angestellten Reisigfütterungsversuche*), RAMM.—*Landw. Jahrb., 21 (1892), Heft 1 und 2, pp. 149–173.*

On the storage of albuminoids in the fattening of grown animals, and some related questions (*Ueber den Eiweissansatz bei der Mast ausgewachsener Thiere, sowie über einige sich hieran anknüpfende Fragen*), TH. PFEIFFER and G. KALB.—*Landw. Jahrb., 21 (1892), Heft 1 und 2, pp. 175–209.*

Field-cured and ensiled meadow grass as feeding stuffs (*Wiesengras und Pressfutter*), E. WOLFF and JUL. EISENLOHR.—*Landw. Jahrb., 21 (1892), Heft 1 und 2, pp. 45–77.*

A convenient method for the estimation of fat in milk (*Eine bequeme Methode zur Bestimmung von Fett in Milch*), EMIL GOTTLIEB.—*Landw. Vers. Stat., 40, Heft 1, pp. 1–27.*

Dairy investigations at the Institute for Animal Physiology, Royal Agricultural School, Vienna (*Milchwirthschaftliche Untersuchungen des thierphysiologischen Instituts der k. k. Hochschule für Bodencultur in Wien*), L. ADAMETZ and M. WILCKENS.—*Landw. Jahrb., 21 (1892), Heft 1 und 2, pp. 131–148.*

Transactions of the Association of Agricultural Experiment Stations in the German Empire at the meeting in Halle, September, 1891.—*Landw. Vers. Stat., 40, Heft 1, pp. 29–80.*

EXPERIMENT STATION NOTES.

ALABAMA COLLEGE AND STATION.—A. J. Bondurant has been elected professor of agriculture and agriculturist to the station vice J. S. Newman, who has become vice director of the South Carolina Station. C. A. Cary, D. V. M., formerly of the South Dakota Agricultural College and Station, has been appointed lecturer on veterinary science.

CALIFORNIA STATION.—The annual report of the director will contain accounts of the work of the agricultural laboratory during the past 3 years; reports on culture investigations at each of the five stations in the State for 1891; articles on special subjects and investigations; and reports on insects, insecticides, and school work in entomology. A report on viticulture will be issued separately. Investigations of soils are being made with special reference to the conditions affecting their hygroscopic, capillary, and water capacities. The results thus far obtained go to show that the last-named power, at least, is not dependent entirely upon the proportion of capillary space or the size of the particles, but that other conditions, such as the presence of humus, have their influence. Among special experiments the reclamation of alkali soil is receiving attention at the Tulare Station.

COLORADO STATION.—F. A. Huntley, B. S., has been appointed assistant agriculturist. N. Andersen, assistant chemist, has resigned to accept a position in New York City. L. M. Taylor has been added to the station staff as stenographer. An agricultural hall and experiment laboratory, costing about $10,000, is nearing completion.

A breeding and feeding experiment with graded sheep has been begun, with a view to obtaining an improved cross on the ordinary ranch ewe. Many sheep owners have been for years making crosses with the Merino breed. Owing to the increased demand for mutton, it is thought by many to be more profitable to breed sheep of greater weight, even if their wool is of a poorer quality. To assist in working out this problem the station has purchased one dozen each of half-breed Merino and Shropshire ewes 2 or 3 years old, all bred on the open range. These are being bred to a 3-year-old typical Shropshire buck weighing 320 pounds. The ewes and their offspring will be cared for alike, and the expense of keeping them will be recorded, as well as the value of the clip of both the ewes and lambs.

KENTUCKY STATION.—C. W. Mathews has become horticulturist of the station. He is a fellow of Cornell University, being the first ever elected to that position from the agricultural department of the university.

NEW HAMPSHIRE COLLEGE.—At the session of the legislature of New Hampshire in 1891 acts were passed removing the college to Durham, accepting as an endowment the Benjamin Thompson estate, valued at over $400,000, and providing $100,000 to be used, with certain other sums, in the erection of buildings. It is expected that the buildings in Durham will be ready for occupation by September, 1893. The necessary transfers will be made during the summer vacation, and will not interfere with the work of the college.

NORTH DAKOTA STATION.—W. M. Hays, B. S. A., formerly assistant agriculturist of the Minnesota Station, has been appointed agriculturist. W. H. Whalen, Ph. B., formerly of the New York State Station, has been appointed assistant chemist. The station has taken possession of new offices and laboratories on its farm, half a mile

north of the city of Fargo, and is now well equipped for work in the lines which it has undertaken.

PENNSYLVANIA COLLEGE AND STATION.—H. J. Waters, assistant agriculturist of the Missouri Station, has been appointed professor of agriculture and agriculturist to the station vice T. F. Hunt, B. S., resigned.

TENNESSEE STATION.—A geographical and chemical study of the typical virgin soils of east Tennessee and the Cumberland Plateau is approaching completion. Collections of plants representing the flora of the region from which the soil samples were taken, were also made. Plans have been perfected for testing special commercial fertilizers on tomatoes and potatoes grown in pots after the Wagner method.

UTAH STATION.—In an experiment in which six lots of pigs were fed for nearly 9 months on different rations, oats gave the largest gain per 100 pounds. Alfalfa proved to be cheap food, though the growth of the animals was slower when it was fed. Pigs fed in the pen made a much slower growth than those allowed to run at large.

BUREAU OF ANIMAL INDUSTRY.—By the regulations for the prevention of Southern cattle plague issued by the Secretary of Agriculture January 11, 1892, no cattle are to be transported from February 15 to December 1, 1892, to any portion of the United States north or south of an area including the States of South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, Texas, Indian Territory, and portions of Tennessee, North Carolina, and Virginia, except by rail, for immediate slaughter, and under the regulations of the Department of Agriculture. Cattle which have been for 90 days in a certain restricted area in Texas may, however, be transported by rail into Colorado, Wyoming, and Montana for slaughter or grazing in accordance with the regulations made by those States and by this Department.

The following are among the results of recent studies on animal parasites:

In experiments to determine the sources of infection of American hogs with the thorn-headed worm, white grubs of the species *Lachnosterna arcuata* were successfully infected with the larvæ of *Echinorhynchus gigas*, but as the parasite has a larger geographical distribution than this insect the experimenter, C. W. Stiles, suspects that *L. hirticula* and *L. dubia* may act as secondary hosts. (For details of this investigation see *Amer. Jour. Comp. Med. and Vet. Arch., December, 1891.*)

Dr. Stiles also proposes a new genus, *Myzomimus* (type species *M. scutatus*, Müller, 1869), for *Spiroptera scutata*, Müller, a nematode of the epithelium of the œsophagus of cattle. (For a preliminary note on this subject see *Amer. Jour. Comp. Med. and Vet. Arch., February, 1892.*)

Investigations by the same author lead him to oppose the theory advanced by Babes regarding the migration of *Pentastomum tænioides* in cattle. He regards an active migration through the intestinal wall and canal as exceptional, while Babes looks upon it as the rule. Experimental infections with *Pentastomum proboscidium*, an American species, have been made and the anatomy, histology, and embryology have been worked out. (For details of this investigation and a bibliography of the order *Linguatula*, see *Comp. rend., d. 1, Soc. d. Biologie, Paris, 1891. pp. 348–351, and Zeitsch. f. wiss. Zoöl., 1891, 52, pp. 85–157.*)

Dr. Stiles has also described a new protozoa, *Coccidium bigeminum*, a parasite in the villosities of the intestines of dogs. (For a preliminary note on this and other parasites see *Bul. d. 1, Soc. Zoöl. d. France, 1891, pp. 163–165.*)

Dr. C. Curtice has made experiments in breeding the cattle tick (*Ixodes bovis*, Riley), which he places in a new genus as *Boöphilus bovis*. Further observations have indicated that kerosene emulsion may be used for the treatment of cattle infested with this parasite. (For details of this work see *Amer. Jour. Comp. Med. and Vet. Arch., July, 1891, and January, 1892.*)

Dr. Curtice has also bred the ox warble and shown that the common American species is *Hypoderma lineata* instead of *H. bovis*. With regard to the migration of

this parasite, he advances the theory that when the larvæ are hatched from eggs laid on the backs of cattle they get into the œsophagus from the animals licking themselves. The parasites then bore into the wall of the œsophagus and thence after a short time through the body of the host until they appear under the skin on the back. The presence of the grubs in the œsophagus was observed in cattle just slaughtered and the grubs have several times been found at considerable distances beneath the skin, but the fact of their migrating through the body has yet to be proved by observation. (See *Amer. Jour. Comp. Med. and Vet. Arch., June, 1891.*)

A. Hassall has found in American cattle a large fluke which he proposes to call *Fasciola americana*. This parasite is much larger than *Distomum hepaticum*. (For a description of the new parasite see *Amer. Vet. Review, July and September, 1891.*)

BELGIUM.—The *Bulletin de l'Agriculture*, vol. VII, No. 7, contains the annual reports for 1890 of the experiment station at Gembloux, and of the agricultural laboratories at Liege, Ghent, Hasselt, Gembloux, Mons, Antwerp, and Louvain. The report of the station contains the titles of the articles published in 1890, as follows: Contribution to the Problem of Nitrogen; Experiment on the Decomposition of the Silicates of Arable Soil by the Oxide and Sulphate of Calcium; Clover Hay, Brown Hay, and Dry Diffusion Chips of Sugar Beets; Chemical and Botanical Analyses of some Belgian Hops; Meteorological Observations; The Chemical Examination of Soils; Experiment on the Assimilability of Phosphatic Slag. The first four of these articles were published in Bulletins Nos. 47 and 48 of the station. The investigations in progress are, experiments regarding the relation of atmospheric nitrogen to plant nutrition; study on the composition of the air and of rain water in their relations to vegetation; experiments regarding the best time to apply Bordeaux mixture for potato rot, and whether iron in some form can not be substituted for the copper in this mixture; continuation of the inquiry on the starch content of different varieties of potatoes; continuation of the chemical examination of Belgian soils; study of the different methods used in the chemical and physical analysis of soils, and meteorological observations.

The agricultural laboratories are engaged in the analysis of fertilizers, foods, feeding stuffs, beverages, sugar beets, soils, etc., with and without control.

TREATMENT OF SOILS WITH SOLUBLE FLUORINE COMPOUNDS.—In view of recent discoveries concerning the antiseptic value of hydrofluoric acid in the manufacture of alcohol, the following contribution from the Brussels *Société générale de Maltose* on the treatment of cultivated soils with soluble fluorine compounds is of interest: Small doses of fluorine were found to be of advantage in malting barley, both in preventing spoiling and in aiding germination. At first the grain was soaked in water acidified with hydrofluoric acid, by which process a small amount of fluorine was absorbed and the seed was at once tested with reference to its germinating power. Later it was found that the beneficial effect on germination was the same whether the seed was tested immediately after treatment with the hydrofluoric acid water or kept for a time, provided the seed had absorbed minute quantities of fluorine. This latter result led to the suggestion that the fluorine might be introduced into the seed through the plant in a more natural way by applying fluorine compounds to the soil. This forms the basis of the claim for a patent. For this purpose all soluble fluorine compounds are said to be available, but the fluorides of potassium, sodium, and ammonium, as well as potassio-sodium fluoride are said to be preferable. Only a limited application is recommended, as an excess would be more likely to prove disastrous than advantageous to the plants. The fluoride must be thoroughly and evenly distributed throughout the soil. It may be applied dry with the fertilizer, or a solution of 5 to 10 grams in 100 liters of water may be sprinkled on the soil. The latter plan is given the preference, as it insures a more even distribution of the fluorine. The kernels of grain raised in soil thus treated absorbed 0.002 per cent of their weight of fluorine salts; and this minute quantity proved sufficient

to bring about the desired effects with reference to malting. This method of supplying the antiseptic to the grain is claimed to be simpler and less expensive than external treatment and quite as effectual.

ALBUMENIZED MILK.—A patent is reported to have been granted by the German Government to Dr. R. Rieth of Berlin, on a method for preparing artificial human milk from the milk of cows. The chief difference between human and animal milk consists in the preponderance of albumen in the former, and of casein in the latter. It is believed to be due mainly to this that human milk is more easily digested than animal milk. Dr. Rieth proposes to retain cows' milk as the basis of his preparation, making certain additions and substitutions so as to approximate both the chemical and the physical composition of human milk. The proportions of fat, sugar, ash, etc., can easily be adjusted by adding to or removing part of them from the cows' milk. The adjustment of the proportions of casein and albumen is more difficult. The removal of part of the casein was not practicable, neither was the addition of natural albumen, since this coagulates by heating and is relatively indigestible. Dr. Rieth proposes to add to the milk pure albumen which has been heated above the boiling point of water and lost its power to coagulate. Albumen thus treated, besides being non-coagulable, is found to be otherwise changed and to very closely resemble albumose in its chemical reactions and physiological action. If it is not an albumose it is believed to be a closely related compound. Recent experiments by Ewald (*Deut. med. Wochensch., 1890, p. 909*) and others go to show that in the peptic digestion of albuminoids the resulting product is chiefly albumose instead of peptones, which were either entirely absent or only present in slight traces; and further that artificially prepared albumose was capable of replacing a part of the albuminoids necessary to sustenance and was easily resorbed. In view of these facts the material suggested by Dr. Rieth would seem, as far as digestibility is concerned, to be well adapted to increasing the albumen content of cows' milk. The principal points claimed for milk prepared in this manner are that (1) it contains no substances foreign to human milk and consists chiefly of cows' milk and materials separated from cows' milk; (2) it is chemically and physiologically identical with human milk; (3) it has the same taste as human milk with no tang or aftertaste; and (4) it can be sterilized or evaporated.

ALUM IN OIL CAKES.—Dr. Moschales reports (*Wochenschr. des landw. Ver. Baden*) having repeatedly found alum up to 4 per cent in rape and palm nut cakes. In one case these cakes are believed to have caused the death of a calf which was fed on them. It is explained that in some factories it is common to sprinkle the material to be extracted with an alum solution which acts upon the cell walls, thus making possible a more thorough extraction of the oil. The author believes that oil cakes from material so treated should be used with great care, and since such treatment would tend to produce cakes with a relatively small fat content he urges that farmers should be cautious about feeding oil cakes poor in fat.

PHOSPHATE MILK.—According to a report in the *Journal de l'Agriculture*, C. Gravier, superintendent of a model farm in Vichy, France, has succeeded by special feeding (not disclosed) in bringing the phosphoric acid content of the milk of a herd of eight cows up to 2.3 to 2.5 grams per liter. The normal content is not far from 1.7 grams per liter of milk. This milk is put up in bottles and sterilized, and is at present used in several hospitals in Paris on account of its supposed therapeutic properties.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING JANUARY, 1892.

DIVISION OF VEGETABLE PATHOLOGY:

Bulletin No. 1.—Additional Evidence on the Communicability of Peach Yellows and Peach Rosette.

DIVISION OF STATISTICS:

Report No. 91 (new series), December, 1891.—Report on the Crops of the Year; Freight Rates of Transportation Companies.

DIVISION OF ENTOMOLOGY:

Insect Life, vol. IV, Nos. 5 and 6, December, 1891.

DIVISION OF BOTANY:

Bulletin No. 12, part II, December, 1891.—Grasses of the Southwest.

WEATHER BUREAU:

Monthly Weather Review, October, 1891.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Record, vol. III, No. 6, January, 1892.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING JANUARY, 1892.

AGRICULTURAL EXPERIMENT STATION OF THE AGRICULTURAL AND MECHANICAL COLLEGE OF ALABAMA:

Bulletin No. 28, November, 1891.—Watermelons and Cantaloupes.

Bulletin No. 29, November, 1891.—Grapes, Raspberries, and Strawberries.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 110, December, 1891.—Notice as to Supply of Station Reports; Sampling and Analyses of Canada Ashes; Substitutes for Canada Ashes.

AGRICULTURAL EXPERIMENT STATION OF FLORIDA:

Bulletin No. 16, January 1, 1892.—Corn, Hay, Weevil, Rice, Cane, Texas Blue Grass, and Cotton.

GEORGIA EXPERIMENT STATION:

Bulletin No. 15, December, 1891.—Fertilizer, Culture, and Variety Experiments on Corn; Culture of Small Fruits.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:

Bulletin No. 16, January, 1892.—Brief Summary of Results in Electroculture; Experiments with Lettuce Grown under the Influence of Dynamical Electricity.

Meteorological Bulletin No. 36, December, 1891.

EXPERIMENT STATION OF MICHIGAN AGRICULTURAL COLLEGE:

Bulletin No. 78, December, 1891.—Glanders and Farcy.

Bulletin No. 79, January, 1892.—Vegetable Tests.

MISSISSIPPI AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 18, January, 1892.—Varieties of Cotton.

AGRICULTURAL EXPERIMENT STATION OF NEBRASKA:

Bulletin No. 18.—Preliminary Report on the Native Trees and Shrubs of Nebraska.

NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS:

Bulletin No. 85, December 18, 1891.—Farm Practice and Fertilizers to Control Insect Injury.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 34, November, 1891.—Dewberries.

Bulletin No. 35, December, 1891.—Combinations of Fungicides and Insecticides, and some New Fungicides.

Bulletin No. 36, December, 1891.—The Effect of a Grain Ration for Cows at Pasture.

OHIO AGRICULTURAL EXPERIMENT STATION:

Bulletin, vol. IV, No. 8 (second series), November, 1891.—Forty Years of Wheat Culture in Ohio.

OKLAHOMA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 1, December, 1891.—General Information, Organization, and History.

Oregon Experiment Station:

Bulletin No. 15, January, 1892.—Horticulture.

Rhode Island State Agricultural Experiment Station:

Bulletin No. 13, September, 1891.—Fertilizers.

Bulletin No. 14, October, 1891.—Potato Scab; the Bordeaux Mixture as a Preventive of Potato Scab and Potato Blight; Transplanting Onions.

South Carolina Agricultural Experiment Station:

Bulletin No. 4 (new series), December, 1891.—Fertilizer Tests with Wheat; Varieties of Wheat and Oats.

South Dakota Agricultural Experiment Station:

Fourth Annual Report, 1891.

Bulletin No. 25, June, 1891.—Glanders.

Bulletin No. 26, July, 1891.—Strawberries, the Sand Cherry, and Orchard Notes.

Tennessee Agricultural Experiment Station:

Bulletin, vol. IV, No. 5, December, 1891.—A Chemical Study of the Cotton Plant.

Wyoming Agricultural Experiment Station:

Bulletin No. 4, December, 1891.—Meteorology for 1891.

U. S. DEPARTMENT OF AGRICULTURE

OFFICE OF EXPERIMENT STATIONS

A. W. HARRIS, DIRECTOR

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EXPERIMENT STATION RECORD.

Vol. III. ISSUED MARCH, 1892. No. 8.

EDITORIAL NOTES.

On pages 557-576 of the present number of the Record an account is given of several series of experiments, the practical details of which were carried out by farmers in a number of places in the Province of Saxony, Prussia. They were under the direction of the experiment station of the Central Agricultural Society of the Province, which is located at Halle, the seat of one of the large German universities. The farmers of this region were in doubt as to the best ways of using certain feeding stuffs, such as the diffusion residue of sugar beets, of which they had large quantities, and concentrated foods, like oil cake and barley meal, which they were in the habit of buying in large amounts for feeding to milch cows and fattening oxen and sheep. The object of the experiments was to get light on the questions of the best ways of utilizing the feeding stuffs, and the kinds and quantities which might be most advantageously fed for making milk and meat.

The supply of each kind of concentrated food, such as oil cake or barley meal, for a group of comparative trials, was bought from one source and distributed to the individual experimenters, and thus all had like materials. For the home-grown products—hay, straw, etc.—each one set aside enough at the outset for the whole experiment. The station analyzed samples of the feeding stuffs and made tests of their digestibility. On the basis of these estimates the rations were made up and fed. The station also made analyses of the milk; and with a view to obtaining more definite knowledge of the structure of the bodies of the fattened animals, composition of the organs, and quality of the meat, arrangements were provided for slaughtering the animals under such conditions that this part of the investigation could be properly carried out by the station. The financial estimates were made from accounts kept in accordance with a system devised by the professor of agricultural bookkeeping of the Agricultural Institute of the University of Leipsic, under whose superintendence the bookkeeping of a number of farms in the region is done. The principles of chemistry and physiology and the professional skill of the veterinarian and the technologist were utilized

as far as practicable, the fundamental idea being to bring all these agencies to bear in such ways as to best help the farmer to help himself. The extent of the investigations, the definiteness of the results, and their practical and educational value are shown in the reports.

No other experimental inquiry regarding the feeding of domestic animals has for a number of years excited so much interest among farmers in Germany. Doubtless this interest is partly due to the share which their fellow farmers have had in the inquiry. But the chief reason is that the results enforce a doctrine which, though not entirely new, now comes before the public with so strong a support of experimental test that it demands the most careful attention.

The doctrine is in substance as follows: We are constantly improving the breeds of our domestic animals. A large part of the improvement is increased productive capacity. We have cows that give more milk; neat cattle, sheep, and swine that fatten better; and horses and oxen that do more work than was expected in former years. For the larger production they need better nourishment. The food that formerly sufficed does not fill the need for the larger production which is wanted and is most profitable to-day. In Germany this principle is expressed in the statement that the old feeding standards do not suffice for the production demanded of the improved stock of to-day. To utilize the productive capacity of such animals, more liberal feeding is essential, and what is needed to fit the food to the demand is increase of protein. Wolff's standards provide enough non-nitrogenous material but not enough nitrogen. Rations richer in protein and with narrower nutritive ratios are needed.

These experiments are of interest to us in the United States in two ways: In the first place they illustrate one of the ways in which our experiment stations may be useful. The experiments were made by the station in coöperation with intelligent farmers. In the planning and in the execution of the work the teachings of science and the demands of practice were both carefully considered. Had the primary object been the study of chemical and physiological laws the investigations might better have been restricted to the laboratory, the stable, and the respiration apparatus. But the object was rather to help the farmer apply the teachings of science to his practice and find in what ways it could be made more rational and profitable. To this end a subject of immediate importance was in each case selected; the questions were made narrow and specific; the specialists of the university and the most intelligent practical men contributed the fruits of their study and experience; the results of information already gained and the teachings of abstract science were utilized. No reasonable pains were spared to make the investigations accurate and thorough, and they are being repeated not only in a number of different places, but through a series of years. In the second place they enforce a lesson of practical value for farmers. The results imply very distinctly that the best production of meat and milk is brought about by liberal feeding and especially by

liberal proportions of protein in the food. They accord with a very large amount of experiment and experience on both sides of the Atlantic in indicating that in regions where the farmer must buy concentrated foods, and especially where he must use artificial fertilizers, the advantage of feeding stuffs rich in protein is very marked.

The reason for this advantage is twofold. The protein is essential for the nutrition of the animals, and with it the carbohydrates and fats of other feeding stuffs can be profitably utilized. The nitrogenous feeding stuffs are an economical source of nitrogen and phosphoric acid for manure. Unfortunately these principles are not always appreciated at their full value. Even in those parts of the United States where the high value of land and nearness to market call for intensive farming, where nitrogenous and phosphatic fertilizers are largely used, and oil cake, bran, corn meal, and like concentrated foods are a necessity, comparatively few farmers or dairymen use such quantities of protein as accurate experiment implies would be profitable. Of course a great deal of investigation will be needed to show just what proportions will be most advantageous for different classes of animals and under the widely different conditions which prevail in the United States, but there is no doubt that one of the essential reforms in our feeding practice will be in using more nitrogenous feeding stuffs.—[W. O. A.]

The experiments above referred to furnish another illustration of the futility of drawing general conclusions from a single trial or a series of trials, and the necessity of numerous repetitions of the same experiment.

In the experiments of series E (page 565) the question was specific and narrow—the effect of the addition of non-nitrogenous food to a ration rich in nitrogen; in other words the old question of wide *vs.* narrow rations. Instead of depending on two or three cows, as is often done, eight were used. They were all fed alike during each of five test periods, with transition periods between, the food being different in the different test periods. The result was a clear gain of live weight with the narrower and loss with the wider ration, while the only change in milk yield was that which naturally came with advance of the period of lactation. The same experiments were made in another place with another lot of cows, and with results practically identical. The inference which seemed to be so clearly warranted by the first series was strikingly confirmed in the second. The same experiments were repeated in a third place with six cows, but the results were the opposite of those of the first two series in respect to both change in live weight and milk yield. The cows of the third series lost weight with the narrower and gained with the wider ration, and the milk yield rose with increase of non-nitrogenous food. There were slight differences in the kinds of food materials in the three cases, but not such as to account for the difference in result. The most plausible hypothesis is that the cows in the last case were in poor condition.—[W. O. A.]

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Florida Station, Bulletin No. 15, October 1, 1891 (pp. 14).

TOBACCO, J. P. DEPASS.—General directions regarding the culture of tobacco, with incidental references to experiments at the station.

Indiana Station, Bulletin No. 36, August, 1891 (pp. 32).

FIELD EXPERIMENTS WITH WHEAT, W. C. LATTA, M. S. (pp. 110–128).—These included tests of varieties, rates of seeding, time of seeding, large *vs.* small seed, rotation *vs.* continuous grain cropping, experiments with fertilizers, and trials of a grain tester. Previous accounts of similar experiments may be found in Bulletins Nos. 27 and 32 of the station (see Experiment Station Record, vol. I, p. 206, and vol. II, p. 326).

Test of varieties.—Tabulated data for 22 varieties tested in 1891, with the average yields of these varieties during from 1 to 8 years. In 1891 the most productive varieties were Jones Winter Fife, Velvet Chaff, and Early Red Clawson. The average yield of Velvet Chaff for 8 years was 31.3 bushels per acre.

Quantity of seed per acre.—Tabulated data are given for the yields of wheat seeded at rates varying from 2 to 8 pecks per acre during 7 years (1885–91). The average yield for the 7 years has been from 22.3 to 31.5 bushels per acre, increasing with increased thickness of seeding.

Early and late seeding.—Tabulated data are given for the yields of wheat sown in 1888, 1889, and 1890 at different dates from September 18 to October 18. The results vary in the different years, but the average yields favor the September sowings.

Large vs. small seed.—Tabulated data are given for experiments during 3 years. The average gain from large seed for the 3 years is 2.5 bushels per acre.

Rotation vs. continuous grain cropping.—The average yields in bushels per acre of all the wheat plats of each series for 5 years (1887–91) were as follows: Grass and grain 21.8, grain alone 16.9, gain from rotation 4.8. No fertilizers have been used on either series of plats since the beginning of the experiment, and the entire crop has been removed in every case.

Commercial fertilizers and stable manure.—This is the second year's report on experiments which are to continue a number of years. Tabulated data are given for the yields of wheat on four series of plats (numbered 2, 3, 4, and 5). The variety of wheat grown was Velvet Chaff. In series 2, 3, and 5 dissolved boneblack, muriate of potash, and sulphate of ammonia, in combination, were compared with horse manure and with no manure. In series 4 the above-mentioned fertilizers were used singly, two by two, and all three together, and compared with horse and cattle manure, plaster, lime, and salt, used singly, and with no manure. The previous cropping of the different series was as follows: In 1889 corn grew on all the plats except those of series 3, devoted to continuous wheat growing. In 1890 series 2 produced barley, and series 4 and 5 oats. "Winter rye was sown in 1889 and an intercrop after corn on series 2, 4, and 5, and was plowed under the next spring for the succeeding crops. Clover has been sown each spring as an intercrop on series 3 and plowed under the same season for the succeeding wheat crop." The following is a general summary of the results of these experiments in 1891:

General averages.	Yield.		Increase.	
	Grain.	Straw.	Grain.	Straw.
	Bushels.	*Pounds.*	*Bushels.*	*Pounds.*
Four fertilized plats of series 2	37.40	5,191	4.34	1,324
Three adjacent plats not fertilized	33.06	3,867		
Four fertilized plats of series 3	32.88	5,110*	3.07	1,582
Three adjacent plats not fertilized	29.81	3,528		
Twelve fertilized plats of series 4	32.31	4,667	—1.71	628
Five adjacent plats not fertilized	34.02	4,039		
Four fertilized plats of series 5	35.69	4,960	4.52	1,257
Three adjacent plats not fertilized	31.17	3,700		
Twenty-four fertilized plats	33.82	4,880†	1.47	1,060
Fourteen adjacent plats not fertilized	32.35	3,820		

*Average of three plats. †Average of twenty-three plats.

The grain tester.—Three trials of the tester, of ten weighings each, were made. In the first trial the wheat was run through a funnel and allowed to fall about 10 inches into the tester, which was then gently tapped three times with the ends of the fingers before taking the struck measure. In the second trial, after running the wheat through the funnel as before, it was lightly pressed with the hand before applying the straight edge. In the third trial the grain was dipped up with a small scoop and lifted just over the edge of the tester, when the scoop was tipped and the wheat run into the tester with as little force as possible. * * *

Velvet Chaff wheat, one of the heaviest varieties grown at this station, was used in all the weighings. * * *

The [average], maximum, and minimum weights, and range of weight, both in pounds and per cent, are all shown in the accompanying table. The per cent of range is based on the minimum weight in every case.

Weight per struck bushel.

	Wheat poured and shaken.	Wheat poured and pressed.	Wheat dipped.
	Pounds.	*Pounds.*	*Pounds.*
Average	66.50	67.23	63.60
Maximum	67.00	67.50	63.75
Minimum	66.00	67.00	63.50
Range { pounds	1.00	0.50	0.25
Range { per cent	1.52	0.75	0.39

The method employed in the third trial is the one recommended by millers, and although it gives the lightest weight per struck bushel, as would be expected, it is evidently the fairest of the three methods used in these trials of the tester.

These trials show (1) that wheat may be readily compressed into a more compact mass; (2) that slight differences in the rate of filling a measure will increase or reduce the quantity of wheat that the measure will hold; and (3) that uniformity in filling the tester is just as important as great care in taking the samples to be weighed. The plain lesson of the experiment is that a number of fair samples of the wheat to be graded should be taken, and each weighed several times in a careful and uniform manner, and the average weight of the samples taken to represent the actual weight per struck bushel of grain. If the above-named precautions are carefully observed the grain tester will show, with approximate accuracy, the average weight of the wheat per struck bushel, and it is therefore recommended as an unvarying and impartial standard for grading wheat.

WHEAT SCAB, J. C. ARTHUR, D. SC. (pp. 129–132).—In 1891 an obscure fungous disease of wheat caused the loss of 10 to 20 per cent of the crop in certain fields near La Fayette, Indiana. It causes parts of the heads to appear prematurely ripe, the kernels affected being shriveled and worthless.

The most prominent feature of the disease is the presence, in the advanced stages, of a pinkish color over the surface of the chaff, especially along the edges and at the base. This color belongs to a very thin layer of adhesive substance which glues the chaff together over the grain, and gives rise to the name scab. * * *

The fungus belongs to the genus *Fusisporium*, or, according to the later classification of Professor Saccardo, to *Fusarium*. It may be the form reported upon wheat in England by Mr. W. G. Smith, and called by him *Fusisporium culmorum*, but it is difficult to be certain from his brief description.

Counts of several thousand heads of wheat indicated that late-sown and poorly grown wheat suffered most, but there was no great difference in the amount of injury to different varieties.

FORMS OF NITROGEN FOR WHEAT, H. A. HUSTON, M. A. (pp. 133–138).—The results are tabulated for 63 plats, each 49½ by 4 feet and separated by strips 1 foot wide, half of which received 7 ounces of nitrogen each either as nitrate of soda, dried blood, or ammonium sulphate, applied either all at once or in two or three fractions.

Indiana Station, Bulletin No. 37, December, 1891 (pp. 12).

COMPARISON OF CUT WITH UNCUT CLOVER HAY, C. S. PLUMB, B. S. (pp. 139–143).—This comparison was made on eight yearling Shorthorn steers, which had previously been at pasture, and lasted from

December 17 to March 27. During this time four animals received cut and four others uncut clover hay, the grain and other foods given being practically the same for both lots. The two lots "ate practically the same amounts of food, there being but 10 pounds difference in round numbers." The cost of the food for each lot at current prices and the gains in live weight are tabulated.

"During the 100 days of feeding lot 1 gained 607 pounds and lot 2, 425 pounds. The average gain per day in lot 1 for each animal is 1.51 pounds, and in lot 2, 1.07 pounds, or nearly 50 per cent in favor of lot 1—the animals fed cut clover—over those fed the uncut."

THE COMPOSITION AND VALUATION OF INDIANA FEEDING STUFFS, H. A. HUSTON, M. A. (pp. 144–150).—This article includes a popular discussion on the food constituents of feeding stuffs; the valuation of these constituents; a comparison of the market selling price and chemical valuation per ton for a variety of feeding stuffs, allowing 1 cent per pound for protein, 2.75 cents for fat, and 0.63 cent for carbohydrates; and a table showing the composition of a large number of feeding stuffs grown or sold in Indiana.

The very great differences between the chemical value of rye, wheat, and barley, and their market value, bring out very forcibly the effect of a demand for these articles for purposes other than cattle feeding. In the same way the demand for oats as a special food keeps its market price generally above its chemical value. * * *

A common practice in pig feeding is to use nearly equal parts of bran, ground oats, and ground barley. A ton of this feed at the prices now prevailing (November, 1891) would cost $21.04, while a mixture of equal parts of bran and corn meal would cost $14.69, or of bran and corn-and-cob meal $13.48.

Certainly here is margin enough to justify a feeder in making a careful examination into his ration to see if a part of it at least can not be replaced by a cheaper material.

Analyses are given for two special foods sold under the names of Powdered Fenugreek and Locust Bean Meal. Calculated on the basis given above the Powdered Fenugreek is valued at $15.89 and the Locust Bean Meal at $11.97 per ton; the former was sold at 4.5 cents per pound or $90 per ton, and the latter at 5.5 cents per pound or $110 per ton.

Maryland Station, Third Annual Report, 1890 (pp. 71).

REPORT OF DIRECTOR, H. E. ALVORD, C. E. (pp. 77–89).—Brief statements regarding the work of the station in different lines, improvements in its equipment, publications issued in 1890, and changes in the station staff.

REPORT OF AGRICULTURIST, A. I. HAYWARD, B. S. (pp. 90–103).

Soil test with corn.—"This experiment is a repetition of the soil test with corn recorded in the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 352). The plats and fertilizers used on them for the 2 years were identical." Hickory King corn was

grown on one half of each plat and Silver Yellow dent on the other. The tabulated yields lead to the following conclusions:

(1) The nitrogen plats gave an increased yield of over 19 bushels as compared with those plats receiving no fertilizer. * * * The cost in the form of nitrate of soda (plat 2) was at the rate of $4 per acre.

(2) Phosphoric acid when applied alone failed in every case except one to equal the average product of the nothing plats; the cost in the form of dissolved bone-black was $6 per acre.

(3) The application of phosphoric acid, or potash, or both, in addition to nitrogen, in no case gave a profitable increase of product.

(4) The largest yield of dried fodder was from plat 7, receiving the "complete fertilizer," but in no case did a large yield of fodder follow the application of either potash or phosphoric acid alone. In every case where nitrogen was used the yield was far above the average.

Coöperative corn test.—The yields are tabulated of corn raised in Maryland from seed grown in New York, Wisconsin, Kentucky, Kansas, Georgia, Texas, and Maryland, being the results obtained by the station in the coöperative corn test planned by the Texas Station in 1890.

The varieties from the more Northern States failed to do well. Although their germination and early growth were good, very few perfect stalks could be found on the plats, and hardly a perfect ear. * * *

The varieties from Kentucky, Kansas, and Maryland being better adapted to this latitude, matured well and made a good growth, while the unusually long season permitted the fair development of the more Southern varieties. In an ordinary season the varieties from Georgia and Texas would have been killed by frost before reaching maturity.

The forage garden.—A report on the growth of grasses, clovers, an unknown pea, and soja beans. The yield of soja beans on 24 unfertilized eighth-acre plats is given. The crop was cut September 16, when in bloom. One plat yielded at the rate of 8 tons per acre, and the total yield of the 3 acres was 13 tons.

Variety test of wheat and oats.—Brief reference is made to the results of tests of 45 varieties of wheat, published in Bulletin No. 10 of the station (see Experiment Station Record, vol II, p. 728), and to an unsuccessful test of 40 varieties of oats.

Rotation plats.—A report of the yield in 1890 on 6 plats laid out in 1888.

Silos and silage.—A brief account of the filling of three silos.

Miscellaneous.—An account of the underdraining of a piece of land, and a description of the Symmes hay cap.

REPORT OF HORTICULTURIST, T. L. BRUNK, B. S. (pp. 104–117).—The author of this report took charge of the horticultural department of the station October 8, 1890, succeeding W. H. Bishop, B. S.

Tomatoes.—The results of experiments in 1889 were published in Bulletin No. 11 of the station (see Experiment Station Record, vol. II, p. 728).

Strawberries.—The tests of varieties in 1889 were reported in Bulletin No. 9 of the station (see Experiment Station Record, vol. II, p. 726).

The percentages of leaf growth and blight (*Sphærella fragariæ*) observed during the autumn of 1889 are recorded for 75 varieties.

Those varieties which had a thrifty growth of 60 per cent and upward, and not over 10 per cent of blight, were the following:

Bidwell	1	Bubach No. 5	5	Gandy	10
Van Deman	2	Bessie	6	Crystal City	10
Anna Forest	2	Cornelia	6	James Vick	10
Haverland	3	Arlington	7	Miner Prolific	10
Hoffman	3	Eureka	8	Jessie	10
Daisy	4	Mrs. Garfield	8		
Ruby	5	Bubach No. 132	10		

Potatoes.—Notes and a tabulated record of yields are given for Early Rose, Early Maine, and Queen of the Valley potatoes in an experiment in which large and small whole tubers, single-eye cuttings, and "pieces as usually cut" were planted. The results as a whole agreed with those of previous years in indicating that "the most profitable seed potatoes, on the average, are those the size of an egg, one whole tuber being planted in each hill."

"Duplicate plantings of both Northern and Southern-grown seed potatoes were made in 1890 at this station and also at the Vermont Station to verify the results of the previous year." The results, as tabulated, for 14 varieties agree with those of 1889 in favoring the Vermont-grown seed. This experiment is also described in the Annual Report of the Vermont Station for 1890 (see Experiment Station Record, vol. III, p. 480).

In every case with the 14 varieties tried the Vermont seed gave more merchantable potatoes than the Maryland seed, and the total product was greater from the Vermont seed in twelve cases out of fourteen. The gross product from Vermont seed was almost double that from the Maryland seed, and the merchantable potatoes were three times as many.

Blackberry rust.—Tabulated data are given regarding the amount of rust observed on 20 varieties of blackberries October 15, 1890. "Those which gave a strong growth of wood and were least affected by the rust were Wilson Early, Wilson Junior, Wachusett, Early Harvest, Crystal White, and Thompson Early Mammoth."

The report also contains brief notes on the orchards and nursery of the station. Experiments with wild and cultivated varieties of grapes are to be undertaken. A fertilizer experiment on apple and peach trees has been begun. Dried blood 240 pounds per acre, muriate of potash 160 pounds, and dissolved boneblack 320 pounds, singly and all three together, were applied for the first time May 16, 1890.

REPORT OF CHEMIST, H. J. PATTERSON, B. S. (pp. 118–129).—This report includes an article on marls; descriptions and analyses of 14 samples of Maryland marls, 1 sample of muck, and 2 samples of marsh mud; and an article on the use of animal charcoal in the determination of fat in feeding stuffs. The following investigations are in progress:

(1) Methods for the determination of hygroscopic moisture in feeding stuffs; (2) effect of food on the digestibility of milk; (3) heat-producing power of various fats,

oils, waxes, and resins; (4) effects of acids and alkalis on germinating seeds; (5) methods of composting marls in order to change the plant food to an available form; (6) sources of phosphates in fertilizers.

The use of animal charcoal in the determination of fat in feeding stuffs.—An account of these studies was also published in the *American Chemical Journal*, vol. VII, No. 4. To purify the ether extract and free it from extraneous matter, it is suggested to place a layer of animal charcoal in the extractor just below the substance to be extracted, from which it is separated by a plug of cotton.

In all cases 1 gram of the substance was used. With grain and meal 1 gram of charcoal was used, and with hay, fodders, and the like, 2 grams. The amount of charcoal can be varied at the discretion of the analyst, but the above amounts were found satisfactory. The animal charcoal was a pure article, of medium fineness, thoroughly dried, extracted with ether and again dried, and preserved for use in a well-stoppered bottle. The cotton was of good quality and clean, and had been extracted with ether previous to use.

The tabulated results of tests with cotton-seed oil, butter fat, mutton tallow, lard, and beef tallow show no appreciable losses from passing ether solutions of pure fat through a layer of charcoal. Comparative determinations of fat by the official method and the modified method were made on a variety of grains, by-products, coarse fodders, and dung from a digestion experiment. The official method gave the higher results in every case, the difference in percentage of ether extract between the two methods ranging from 0.1 (corn meal) to 3.59 (dried tomatoes), and amounting in the majority of cases to over 1.5 per cent.

A few tests of the amount of acid in the extracts, soluble in cold water, were made by titrating it with deci-normal sodium hydrate, phenol phthalein being used as an indicator. In nearly every case some acid was found in the extract of method 1 [official method], reaching over 1 c. c. in some cases, there being scarcely a trace from the extract of method 2. The only case in which there was an appreciable amount of acid in the extract of method 2 was from the sorghum silage. This on further research was found to be due to the acetic acid which such samples contain. After the trial of a number of materials for removing this it was found that by mixing copper dust or filings with the charcoal the acid could be reduced to an inappreciable amount.

The results and the general appearance of the ether extract by the two methods lead the author to believe "that the use of charcoal results in a closer approximation to the truth than any other method in use, though absolute accuracy is not claimed."

REPORT OF MECHANICAL DEPARTMENT, E. H. BRINKLEY (pp. 130–132).—A brief account of the work of this department of the station, with descriptive notes on various farm implements purchased during 1890. The more complete equipment of the station with reference to making tests of farm machinery is urged.

SPECIAL REPORT ON SUGAR BEETS, E. H. BRINKLEY (pp. 133, 134).—An account of an experiment in growing 5 varieties of sugar beets for the U. S. Department of Agriculture. The samples analyzed averaged

10.25 ounces in weight, with a sugar content of 12.2 per cent and a purity coefficient of 79.7. The best lot of beets averaged 20.9 per cent of sugar, with a purity of 94.7.

FINANCIAL REPORT (p. 135).—A statement of receipts and expenditures for the fiscal year ending June 30, 1890.

METEOROLOGICAL RECORD (pp. 136–142).—A tabulated monthly record for 1890. The yearly summary is as follows: *Air temperature* (degrees F.).—Maximum 102, July 8; minimum 12, December 28; mean 55.8; mean maximum 67.3; mean minimum 45; mean daily range 22.3. *Precipitation.*—Total (inches) 36.29; number of rainy days 151.

Massachusetts Hatch Station, Bulletin No. 16, January, 1892 (pp. 8).

ELECTROCULTURE OF PLANTS, C. D. WARNER, B. S.—This includes a brief résumé of investigations on the effect of electric currents on the growth of plants, and a report on experiments at the station with lettuce grown under the influence of dynamical electricity. The substance of the bulletin is as follows:

From the time electricity became a science, much research has been made to determine its effect, if any, upon plant growth. The earlier investigations gave, in many cases, contradictory results. * * * Such men as Jolabert, Nollet, Mainbray, and other eminent physicists affirmed that electricity favored the germination of seeds and accelerated the growth of plants, while on the other hand Ingenhouse, Sylvestre, and other savants denied the existence of this electric influence. The heated controversies and animated discussions attending the opposing theories stimulated more careful and thorough investigations, which established beyond a doubt that electricity had a beneficial effect on vegetation. Sir Humphrey Davy, Humboldt, Wollaston, and Becquerel occupied themselves with the theoretical side of the question; but it was not till after 1845 that practical electroculture was undertaken. Williamson suggested the use of gigantic electrostatic machines, but the attempts were fruitless. The methods most generally adopted in experiments consisted of two metallic plates—one of copper and one of zinc—placed in the soil and connected by a wire. Sheppard employed the method in England in 1846 and Forster used the same in Scotland. In the year 1847 Hubeck in Germany surrounded a field with a network of wires. Sheppard's experiments showed that electricity increased the return from root crops, while grass perished near the electrodes, and plants developed without the use of electricity were inferior to those grown under its influence. Hubeck came to the conclusion that seeds germinated more rapidly and buckwheat gave larger returns; in all other cases the electric current produced no result. Professor Fife in England and Otto von Ende in Germany carried on experiments at the same time, but with negative results, and these scientists advised the complete abandonment of applying electricity to agriculture. After some years had elapsed Fichtner began a series of experiments in the same direction. He employed a battery, the two wires of which were placed in the soil parallel to each other. Between the wires were planted peas, grass, and barley, and in every case the crop showed an increase of from 13 to 27 per cent when compared with ordinary methods of cultivation.

Fischer of Waldheim, believing atmospheric electricity to aid much in the growth and development of plants, made the following tests: He placed metallic supports, to the number of about 60, around each hectare (2.47 acres) of loam; these supports were provided at their summit with electrical accumulators in the form of crowns

surmounted with teeth; these collectors were united by metallic connection. The result of this culture applied to cereals was to increase the crop by half.

The following experiment was also tried: Metallic plates 65 by 40 cm. were placed in the soil. These plates were alternately of zinc and copper and placed about 30 m. apart, connected two and two, by a wire. The result was to increase from two-fold to fourfold the production of certain garden plants. Fischer says it is evidently proved that electricity aids in the more complete breaking up of the soil constituents. Finally he says that plants thus treated mature more quickly, are almost always perfectly healthy, and are not affected with fungoid growth.

Later, N. Specnew, inspired by the results arrived at by his predecessors, was led to investigate the influence of electricity on plants in every stage of their development; the results of his experiments were most satisfactory and of practical interest. He began by submitting different seeds to the action of an electric current and found that their development was rendered more rapid and complete. He experimented with the seeds of haricot beans, sunflowers, and winter and spring rye. Two lots of 12 groups of 120 seeds each were plunged into water until they swelled, and while wet the seeds were introduced into long glass cylinders, open at both ends. Copper disks were pressed against the seeds, the disks were connected with the poles of an induction coil, the current was kept on for 1 or 2 minutes and immediately afterwards the seeds were sown. The temperature was kept from 45° to 50° F., and the experiments repeated four times. The following table shows the results:

	Peas.	Beans.	Barley.	Sunflowers.
	Days.	*Days.*	*Days.*	*Days.*
Electrified seeds developed in	2.5	3	2	8.5
Nonelectrified seeds developed in	4	6	5	15

It was also observed that the plants coming from electrified seeds were better developed, their leaves were much larger, and their color brighter than in those plants growing from nonelectrified seeds. The current did not affect the yield.

At the Botanical Gardens at Kew, the following experiment was tried: Large plates of zinc and copper (0.145 m. and 0.712 m.) were placed in the soil and connected by wires so arranged that the current passed through the ground; the arrangement was really a battery of (zinc | earth | copper). This method was applied to pot herbs and flowering plants and also to the growing of garden produce; in the latter case the result was a large crop and the vegetables grown were of enormous size.

Extensive experiments in electroculture were also made at Pskov, Russia. Plats of earth were sown to rye, corn, oats, barley, peas, clover, and flax; around these respective plats were placed insulating rods, on the top of which were crown-shaped collectors—the latter connected by means of wires. Atmospheric electricity was thus collected above the seeds and the latter matured in a highly electrified atmosphere; the plats were submitted to identical conditions and the experiments were carried on for 5 years. The results showed a considerable increase in the yield of seed and straw, the ripening was more rapid, and the barley ripened nearly 2 weeks earlier with electroculture. Potatoes grown by the latter method were seldom diseased—only 0 to 5 per cent against 10 to 40 per cent by ordinary culture.

Grandeau, at the School of Forestry at Nancy, found by experiment that the electrical tension always existing between the upper air and soil stimulated growth. He found plants protected from this influence were less vigorous that those subject to it.

Macagno, also believing that the passage of electricity from air through the grapevine to the earth would stimulate growth, selected a certain number of vines, all of the same variety and all in the same condition of health and development. Sixteen vines were submitted to experiment and sixteen were left to natural influences. In

the ends of the vines under treatment pointed platinum wires were inserted, to which were attached copper wires leading to the tops of tall poles near the vines; at the base of these same vines other platinum wires were inserted and connected by copper wires with the soil. At the close of the experiment, which began April 15 and lasted till September 16, the wood, leaves, and fruit of both sets of vines were submitted to careful analysis with the following results [as regards the fruit]:

	Without conductor.	With conductor.
	Per cent.	*Per cent.*
Moisture	78.21	79.84
Sugar	16.86	18.41
Tartaric acid	0.88	0.791
Bitartrate of potash	0.18	0.186

Thus we see that the percentage of moisture and sugar is greater and the undesirable acid lower in those grapes subject to electrical influences than in those left to natural conditions. There are also experiments which prove the beneficial effects of electricity on vines attacked by Phylloxera.

The following experiments were made at this station: Several plats were prepared in the greenhouse, all of which had the same kind of soil and were subjected to like influences and conditions. Frames in the form of a parallelogram, about 3 by 2 feet, were put together; across the narrow way were run copper wires in series of four to nine strands, each series separated by a space about 4 inches wide, and the strands by a space of one half inch. These frames were buried in the soil of the plat at a little depth, so that the roots of the garden plants set would come in contact with the wires, the supposition being that the currents of electricity passing along the wires would decompose into its constituents the plant food in the vicinity of the roots and more readily prepare it for the plants. Two electric gardens were thus prepared and each furnished with two common battery cells, so arranged as to allow continuous currents to pass through each series of wires. Near each electric garden was a plat prepared in the same manner, save the electrical apparatus. We will call the two gardens A and B.

The place chosen for the experiments was in a part of the greenhouse which is given up largely to the raising of lettuce, and the gardens were located where much trouble from mildew had been experienced. The reason for this choice of location was to notice the effect, if any, of electricity upon mildew, this disease being, as is well known, a source of much trouble to those who desire to grow early lettuce. The soil was carefully prepared, the material being taken from a pile of loam commonly used in the plant house.

Garden A was located where mildew had been the most detrimental. The experiments began the first of January and closed the first of April. For the garden fifteen lettuce plants of the head variety were selected, all of the same size and of the same degree of vitality, as nearly as could be determined; the plants were set directly over the wires, so that the roots were in contact with the latter; the plants were well watered and cared for as in ordinary culture, and the fluid in the battery cells was renewed from time to time, that the current of electricity might not become too feeble. At the close of the experiments the following results were noted: Five plants died from mildew; the others were well developed and the heads large. The largest heads were over the greatest number of wires and nearest the electrodes. It was further noticed that the healthiest and largest plants, as soon as the current became feeble or ceased altogether, began to be affected with mildew. On examining the roots of the plants it was found that they had grown about the wires, as if there they found the greatest amount of nourishment; the roots were healthy and in no way appeared to have been injured by the current, but rather much benefited by the electrical influences.

Beside garden A was prepared another plat of the same dimensions, having the same kind of soil and treated in like manner as the first, but the electrical apparatus and wires were wanting. At the close of the experiments only three plants had partially developed and two of these were nearly destroyed by mildew—one only was free from the disease. The results therefore show that the healthiest and largest plants grew in the electric plat.

In the second experiment, which we called B, twenty plants of the same variety of lettuce and of equal size were taken. The treatment given was the same as the plants in garden A received. Five plants only remained unaffected with mildew; seven died from the disease when they were half grown; the rest were quite well developed, but at the last part of the experiment began to be affected. Several heads were large, the largest being over the greatest number of wires and nearest the electrodes. Examination of the roots disclosed the same phenomena as in A.

Near garden B were also set twenty other plants, subjected to like conditions as the first, but without electricity; all but one died from mildew before they were half grown, the solitary plant that survived being only partly developed at the close of the experiment, and even this was badly affected with the disease.

Everything considered, the results were in favor of electricity. Those plants subjected to the greatest electrical influence were hardier, healthier, larger, had a better color, and were much less affected by mildew than the others. Experiments were made with various grasses, but no marked results were obtained.

Massachusetts Hatch Station, Meteorological Bulletin No. 36, December, 1891 (pp. 4).

A daily and monthly summary for December, 1891, and a yearly summary for 1891 of observations made at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

The yearly summary for 1891 is as follows: *Pressure* (inches).—Actual maximum reading 30.44, November 19, 10 a. m.; actual minimum reading 28.40, January 12, 6 a. m.; mean reduced to sea level 30.018; annual range 2.04. *Air temperature* (degrees F.).—Maximum 91.5, June 16; minimum 0, February 15; mean 49.7; annual range 91.5; maximum mean daily 79.6, June 15, 16; minimum mean daily 11.3, March 2; mean maximum 57.2; mean minimum 41.8; mean daily range 15.4; maximum daily range 39, May 10; minimum daily range 2, March 9, December 25. *Humidity.*—Mean dew-point 40.1; mean force of vapor 46.45; mean relative humidity 66.8. *Wind* (prevailing direction).—N 19 per cent; S 13 per cent; NW 12 per cent; SSW 11 per cent; total movement 45,212 miles; maximum daily movement 443 miles, March 14; minimum daily movement 3 miles, January 1; mean daily movement 151.3 miles; mean hourly velocity 6.3 miles; maximum pressure per square foot 16.25 pounds—57 miles per hour—January 23, 3 p. m. *Precipitation.*—Total rainfall or melted snow 34.82 inches; number of days on which 0.01 inch of rain or melted snow fell 112; total snowfall in inches 54.25. *Weather.*—Mean cloudiness observed 53 per cent; total cloudiness recorded by the sun thermometer 2,220 hours, or 50 per cent; number of clear days 145; number of fair days 103; number of cloudy days 117. *Bright sunshine.*—Number of hours recorded 2,245; mean ozone 48 per cent. *Dates of frost.*—Last, May 19; first, October 12. *Dates of snow.*—Last, May 5; first, November 26.

Michigan Station, Bulletin No. 78, December, 1891 (pp. 16).

GLANDERS AND FARCY, E. A. A. GRANGE, V. S. (plates 3).—An account of the cause, symptoms, and effects of glanders in different forms as it appears in horses and men. The bulletin is illustrated with three colored plates showing important lesions which occur in typical cases.

Nebraska Station, Bulletin No. 18 (pp. 32).

A PRELIMINARY REPORT ON THE NATIVE TREES AND SHRUBS OF NEBRASKA, C. E. BESSEY, PH. D.—A classified list of 61 species of trees and 64 of shrubs with brief descriptive notes, and lists showing the distribution of these species with reference to elevation and different parts of the State. The following species are included: Yellow pine (*Pinus ponderosa*, var. *scopulorum*), juniper (*Juniperus communis*), red cedar (*J. virginiana*), greenbrier (*Smilax hispida*), white oak (*Quercus alba*), post oak (*Q. stellata*), bur oak (*Q. macrocarpa*), yellow oak (*Q. muhlenbergii*), low yellow oak (*Q. prinoides*), red oak (*Q. rubra*), scarlet oak (*Q. coccinea*), scrub oak (*Q. ilicifolia*), black oak (*Q. nigra*), laurel oak (*Q. imbricaria*), ironwood (*Ostrya virginiana*), hazelnut (*Corylus americana*), speckled alder (*Alnus incana*), canoe birch (*Betula papyrifera*), black birch (*B. occidentalis*), red birch (*B. nigra*), butternut (*Juglans cinerea*), black walnut (*J. nigra*), shellbark hickory (*Hicoria ovata* [*Carya alba*]), big hickory nut (*H.* [*C.*] *sulcata*), mocker nut (*H. alba* [*C. tomentosa*]), pignut (*H. glabra* [*C. porcina*]), bitter hickory (*H. minima* [*C. amara*]), black willow (*Salix nigra*), almond willow (*S. amygdaloides*), shining willow (*S. lucida*), sand-bar willow (*S. longifolia*), beaked willow (*S. rostrata*), prairie willow (*S. humilis*), dwarf willow (*S. tristis*), diamond willow (*S. cordata*, var. *vestita*), quaking asp (*Populus tremuloides*), balsam poplar (*P. balsamifera*, var. *candicans*), black cottonwood (*P. angustifolia*), cottonwood (*P. monilifera*), white elm (*Ulmus americana*), red elm (*U. fulva*), hackberry (*Celtis occidentalis*), red mulberry (*Morus rubra*), plane tree (*Plantanus occidentalis*), grease wood (*Sarcobatus vermiculatus*), creeping barberry (*Berberis repens*), moonseed (*Menispermum canadense*), papaw (*Asimina triloba*), basswood (*Tilia americana*), prickly ash (*Xanthoxylum americanum*), smooth sumac (*Rhus glabra*), dwarf sumac (*R. copallina*), poison ivy (*R. toxicodendron*), low sumac (*R. canadensis*, var. *trilobata*), Ohio buckeye (*Æsculus glabra*), mountain maple (*Acer glabrum*), silver maple (*A. saccharinum* [*dasycarpum*]), sugar maple (*A. barbatum* [*saccharinum*]), box elder or ash-leaved maple (*A. negundo* [*Negundo aceroides*]), bittersweet (*Celastrus scandens*), waahoo (*Euonymus atropurpureus*), strawberry bush (*E. americanus*), trailing strawberry bush (*E. americanus*, var. *obovatus*), bladder nut (*Staphylea trifolia*), low buckthorn (*Rhamnus alnifolia*), buckthorn (*R. lanceolatus*), Indian cherry (*R. caroliana*), New Jersey tea (*Ceanothus americanus*), red root (*C. ovatus*), summer grape (*Vitis æstivalis*), frost grape (*V. cordifolia*), early wild grape (*V. riparia*), Virginia creeper (*Parthenocissus* [*Ampelopsis*]

quinquefolia), kinnikinnik (*Cornus sericea*), rough-leaved dogwood (*C. asperifolia*), red osier dogwood (*C. stolonifera*), dogwood (*C. candidissima*), prickly gooseberry (*Ribes cynosbati*), smooth gooseberry (*R. gracile*), wild red currant (*R. cereum*), wild black currant (*R. floridum*), golden currant (*R. aureum*), witch hazel (*Hamamelis virginiana*,) buffalo berry (*Shepherdia argentea*), wild plum (*Prunus americana*), sand cherry (*P. pumila*), chokecherry (*P. virginiana*), dwarf wild cherry (*P. demissa*), wild black cherry (*P. serotina*), nine bark (*Niellia opulifolia*), red raspberry (*Rubus strigosus*), black raspberry (*R. occidentalis*), blackberry (*R. villosus*), mountain mahogany (*Cercocarpus parvifolius*), climbing prairie rose (*Rosa setigera*), prairie rose (*R. arkansana*), tall rose (*R. fendleri*), low rose (*R. woodsii*). wild crab apple (*Pyrus coronaria*), hawthorn (*Cratægus tomentosa*), hawthorn (*C. coccinea*), service berry (*Amelanchier canadensis*), small service berry (*A. alnifolia*), bearberry (*Arctostaphylos uva-ursi*), shoe string (*Amorpha canescens*), false indigo (*A. fruticosa*), redbud (*Cercis canadensis*), Kentucky coffee tree (*Gymnocladus canadensis*), honey locust (*Gleditsia* [*Gleditschia*] *triacanthos*), white ash (*Fraxinus americana*), green ash (*F. viridis*), red ash (*F. pubescens*), buttonbush (*Cephalanthus occidentalis*), elder (*Sambucus canadensis*), sheepberry (*Viburnum lentago*), Indian currant (*Symphoricarpos vulgaris*), wolfberry or buck brush (*S. occidentalis*), snowberry (*S. racemosus*, var. *pauciflorus*), trumpet honeysuckle (*Lonicera sempervirens*), yellow honeysuckle (*L. flava*), small honeysuckle (*L. glauca*), sagebrush (*Artemisia tridentata*), little sagebrush (*A. cana*), wormwood (*A. filifolia*), green grease wood (*Gutierrezia euthamiæ*).

The bulletin also contains the following statements regarding the origin of the Nebraska trees and shrubs:

A close study of the facts as to the distribution of our woody plants shows that nearly all have probably migrated to the plains from the East. They have in some cases done no more than to get a little foothold in the extreme southeastern counties, to which they have come from the heavy forests of Missouri. A few have doubtless crossed the Missouri River from western Iowa, although this number is evidently very small. Nearly all our trees have come up the Missouri bottoms and spread from the southeastern corner of the State west and northwest. Possibly a few may have come up the Blue River from Kansas, but these must eventually be traced to the Missouri River bottoms at the mouth of the Kansas River.

The trees and shrubs which are found only in the western part of the State unquestionably came from the Rocky Mountains, and have spread eastward to their present limits. Only one of these, the buffalo berry, has spread itself over the whole State. There is a probability that a careful examination of the bluffs of the Niobrara, Platte, and Republican Rivers will show several more of these Rocky Mountain plants, which have come down with the river currents. It is singular that so few of the western trees and shrubs have come down the streams, especially as prevailing winds are also from the westerly parts toward the east. One certainly would have supposed it much easier for the Western trees to come downstream and with the wind than for the elms, ashes, plums, etc., to have gone up the streams against the prevailing winds.

I suspect the meaning of all this is that Eastern conditions are slowly advancing westward; that such climatic and other changes are slowly taking place upon

the plains as favor the Eastern rather than the Western trees. With our present knowledge it now appears probable that the Western trees are slowly retreating, while the Eastern species are slowly pushing their way westward.

New Jersey Stations, Bulletin No. 84, October 10, 1891 (pp. 12).

GROUND BONE AND MISCELLANEOUS SAMPLES, E. B. VOORHEES, M. A.—Analyses are given of 30 samples of bone, 13 of dissolved bone and superphosphates with potash, and of tobacco stems ground and unground, tobacco and sulphur, gas lime, hen manure, fish scrap, odorless phosphate, and hair manure.

"A relatively small quantity of ground bone is used in the State; less than 2,000 tons were reported to have been sold during the season of 1890 by the manufacturers of complete fertilizers; to this should be added the product of small bone mills, which would probably increase the total product to 3,000 tons per annum. The samples examined this year are of good quality and of average mechanical composition."

New York Cornell Station, Bulletin No. 34, November, 1891 (pp. 38).

THE DEWBERRIES, L. H. BAILEY, M. S. (pp. 275–312, figs. 8).—"Within the last few years several varieties of dewberries have come into more or less prominence. The greatest differences of opinion exist as to their merits, and no systematic attempt has been made to determine their peculiarities and values. * * * This account endeavors to collect and sift whatever evidence may exist concerning the dewberries, and to put on record so much of the histories and varietal peculiarities as the author has been able to obtain." The botanical relations of the different species of dewberries are discussed and a history and description of the 12 varieties which have been introduced to cultivation are given, with illustrations of plants and fruit. Reference is made to articles on the dewberry by the author in the *American Garden* for November, 1890, and February, 1891. The following summary is taken from the bulletin:

1. The cultivated dewberries represent 2 distinct species of *Rubus* or bramble, and 2 well-marked botanical varieties. It is therefore reasonable to expect that different managements may be required in the different classes, or at least that various results will be obtained from their cultivation.

2. The botanical types to which the cultivated dewberries belong are these: (1) The Northern dewberry (*Rubus canadensis*); to this type belong the Windom, Lucretia Sister, and Geer; (*a*) the Lucretia subtype (var. *roribaccus*), comprising the Lucretia; (*b*) the Bartel subtype (var. *invisus*); to this belong Bartel or Mammoth, General Grant, and Never Fail. (2) Southern dewberry (*Rubus trivialis*); here belong Fairfax, Manatee, Bauer, and Wilson White.

3. The dewberries are distinguished from the blackberries by a true trailing habit, cymose and few-flowered infloresence, and the habit of propagating by means of "tips." Like the blackberries and raspberries, they bear their fruit upon canes of last year's growth, and these canes die or become weak after they have fruited. They are propagated by means of "tips" and root cuttings.

4. The peculiar merits of the dewberries as cultivated fruits are, earliness, large size, attractive appearance, and the ease with which they can be protected in winter.

5. The peculiar demerits of the dewberries are, failure of the flowers to set, formation of nubbins, and difficulty of picking the fruit. There is no positive method known by which the first two difficulties can be overcome, and the causes of them are unknown, but there is reason to believe that pruning and thinning of the canes will tend to make the plant productive. The labor and unpleasantness of picking may be avoided by training the plants on a rack or trellis and by keeping them well pruned.

6. Various methods of training and cultivation are advised, but the plants are generally set at about the same distance as blackberries (3 by 7 or 4 by 7 feet) and the canes are allowed to lie upon the ground, being headed in when they reach about 3 feet in length. A mulch of straw beneath the canes keeps the berries clean and renders picking more pleasant. A wire trellis like a grape trellis or various styles of racks may be used upon which to tie the fruiting canes, and for amateur cultivation, at least, some such upright training seems to be advisable. Only four to six fruiting canes should be allowed to the plant. Some varieties, particularly Windom and Bartel, appear to do best if the fruit is shaded.

7. Twelve varieties of dewberry have been named and more or less disseminated during the last 20 years. Of these, 4 (omitting the Mammoth) have gained more or less prominence, and are found to possess decided merits in certain places. This is a fair proportion of good varieties to inferior ones, as indicated by the annals of other fruits.

8. Many persons have found dewberry culture to be profitable. This is evidence that the fruit is an acquisition. But it has not yet found general favor, and it is probable that it will never become as popular as the blackberry. The varieties which enjoy most prominence are Windom, Lucretia, Bartel, and Manatee.

9. The Windom possesses promise for the Northwest, of which it is a native. It has not yet been tested to any extent elsewhere. It appears to demand partial shade for the best success.

10. The Lucretia has been found to be a desirable and profitable fruit in many places over a large extent of territory, and it is therefore safe to conclude that its range of adaptation is large. Many, however, have failed with it. It appears to be variable, and many of the plants are worthless. It is seriously attacked by anthracnose and by a bramble rust.

11. Bartel has found great favor with some growers in the West, from Wisconsin to Nebraska. It has not succeeded well in the East so far. Some of the variety known as Mammoth appears to be identical with Bartel.

12. Manatee is probably valuable for the South, and it appears to be the most useful form of *Rubus trivialis* yet tested.

13. Since this paper was written roots of 2 new dewberries—Skagit Chief and Belle of Washington—have been received from Avon, Washington. The varieties are not yet introduced and their botanical features have not been studied.

New York Cornell Station, Bulletin No. 35, December, 1891 (pp. 26).

COMBINATIONS OF FUNGICIDES AND INSECTICIDES, AND SOME NEW FUNGICIDES, E. G. LODEMANN, B. S. (pp. 315–338).—This includes notes and tabulated data for experiments at this station and a brief summary of similar experiments at other stations. In the experiments at the New York Cornell Station—

The applications were made to branches of apple, peach, quince, and grape; rows of potatoes and eggplants were used, others being kept as checks. Only three

applications were made to eggplants. This was more than was required to destroy the insects. The foliage of the potatoes began to die about the middle of August, so that no definite observations could be made later. All applications were made with a knapsack pump and Vermorel nozzle. The combinations were mixed immediately before being applied.

None of the plants were attacked by fungi except quinces, so that it was only upon these that some of the combinations could be tested as fungicides. Potatoes and eggplants were used to determine what action the combination would have upon insects.

The intention was to spray about every 10 days, but as much rain fell in July the applications were made more frequently. * * *

The hydrate, the borate, and the chloride of copper were applied to pumpkin and squash vines, which are usually attacked by mildew (*Oidium erysiphoides*, var. *cucurbitarum*), in order to determine their real value as fungicides more accurately than could be done upon the quinces. The Bordeaux mixture was used for comparison.

The fungicides and insecticides used were as follows:

(1) Ammoniacal carbonate of copper (3 or 1.5 ounces carbonate, 1 or 0.5 quarts ammonia, 22 gallons water), with Paris green or London purple (1 pound, 200 or 300 gallons water).

(2) Carbonate of copper in suspension (3 or 1.5 ounces, 22 gallons water) with Paris green or London purple (1 pound to 200 gallons water).

(3) Sulphate of copper (0.25 or 0.5 pound, 22 gallons water) with Paris green or London purple (1 pound, 200 gallons water).

(4) Hydrate of copper (0.5 pound, 22 gallons water) alone or with Paris green (1 pound to 300 gallons water).

(5) Hydrate of copper (0.25 or 0.125 pound, 22 gallons water) alone.

(6) Borate of copper (0.5 pound, 22 gallons water) alone or with Paris green (1 pound, 200 gallons water).

(7) Borate of copper (0.25 pound, 22 gallons water) alone.

(8) Ammoniacal borate of copper (3 ounces borate, 1 quart ammonia, 22 gallons water) with Paris green (1 pound, 200 gallons water).

(9) Chloride of copper (1.5 ounces, 22 gallons water) alone or with Paris green (1 pound, 200 gallons water).

(10) Chloride of copper (3 ounces, 22 gallons water) alone.

The following summary is taken from the bulletin:

1. *Carbonate of copper.*—(1) The action of the ammoniacal carbonate of copper as a fungicide does not appear to be lessened by the addition of Paris green or London purple.

(2) The ammoniacal carbonate of copper gave better results as a fungicide when used at the rate of 1.5 ounces dissolved in 1 pint of ammonia diluted with 22 gallons of water than when 3 ounces of the carbonate and 1 quart of ammonia were used.

(3) The fungicidal action of a combination of the carbonate of copper, held in suspension in water, and the arsenites is not marked.

(4) Combinations of the ammoniacal carbonate of copper and Paris green or London purple, or of the carbonate of copper suspended in water and these arsenites, have a caustic action upon foliage as a rule.

(5) Paris green renders the ammoniacal carbonate of copper more caustic than does an equal amount of London purple.

(6) But when London purple is applied in connection with carbonate of copper held in suspension in water the combination is more caustic than one in which an equal amount of Paris green is used.

2. *Sulphate of copper.*—(1) The effect of the combinations of the sulphate of copper and Paris green or London purple upon fungi was unsatisfactory.

(2) The action of the commercial sulphate of copper upon foliage is uncertain.

(3) The injury done to foliage by the sulphate of copper was increased from 10 to 20 per cent by the addition of Paris green or London purple.

3. *Hydrate of copper.*—(1) When the hydrate of copper is applied alone it is not so effective against fungi as when applied in the Bordeaux mixture.

(2) Two applications of the hydrate reduced injury from fungi at least 5 per cent when used at the rate of 0.125 pound in 22 gallons of water.

(3) The hydrate of copper when applied alone did little injury to the foliage, only the peach being affected.

(4) The caustic properties of the hydrate is increased by the addition of Paris green. The peach was injured 35 per cent by such a combination.

4. *Borate of copper.*—(1) The borate of copper when applied in an undissolved condition has little fungicidal action.

(2) When applied at the rate of 0.5 pound in 22 gallons of water, two applications reduced injury from fungi about 20 per cent.

(3) The action of the borate of copper upon foliage was caustic when the substance was applied in connection with Paris green or Paris green and ammonia. The foliage of the quince, apple, pear, and eggplant suffered least when no ammonia was used. When ammonia was used only the eggplant escaped injury.

(4) The borate of copper possesses no advantages over the carbonate, but its action is similar to it.

5. *Chloride of copper.*—(1) The chloride of copper as a fungicide gave better results than the Bordeaux mixture. When used at the rate of 3 ounces in 22 gallons of water two applications reduced injury from mildew 35 per cent.

(2) Solutions of copper chloride must be weak. One application at the rate of 1.5 ounce of the chloride in 22 gallons of water injured the foliage of apple and peach trees.

(3) Paris green increases the caustic action of a solution of the chloride of copper.

6. *Arsenites.*—(1) Paris green when applied in connection with the ammoniacal carbonate of ammonia does more injury to foliage than would an equal amount of London purple.

(2) London purple, when applied in connection with the carbonate of copper held in suspension in water, does more injury to foliage than would an equal amount of Paris green.

(3) London purple and Paris green increase the caustic action of the ammoniacal carbonate of copper, of the carbonate of copper suspended in water, of the sulphate, hydrate, borate, and chloride of copper when insecticide and fungicide were applied together.

(4) The injury done to foliage by the combinations is probably due to the arsenite which is dissolved by the ammonia or the fungicide.

7. *Varieties.*—(1) Some varieties of certain fruits appear to be more susceptible than others to injury from the combinations.

(2) The foliage of eggplants is the only foliage which was not injured by any of the combinations.

Ohio Station, Bulletin Vol. IV, No. 8 (Second Series), November, 1891 (pp. 30).

FORTY YEARS OF WHEAT CULTURE IN OHIO, C. E. THORNE (pp. 159–186, maps 7).—A statistical study with reference to the "relative adaptability to wheat culture of soils of different geologic origin and history, and the effect of differences of latitude, drainage, and the use of commercial fertilizers." The total yield and average yield per acre of wheat in Ohio for each of 40 years (1850–89) are given in a table,

and the average yields per acre in each county of the State for four periods of 10 years each are shown with the aid of maps. The average yields in bushels per acre in the State during periods of 10 years each were as follows: 12.3 in 1850–59, 11 in 1860–69, 13.4 in 1870–79, 13.7 in 1880–89. "During the 40-year period under consideration there have been seven seasons in which the average yield for the State fell below 10 bushels per acre."

"The farmers of Ohio are now spending nearly a million dollars annually in the purchase of commercial fertilizers, which are chiefly used in the production of wheat. These fertilizers were not purchased in large quantity previous to 1875, but since that date their use has rapidly increased." From a map "on which the average annual expenditure for fertilizers for each acre sown in wheat in the various counties of the State is shown for 10 years" (1880–89), it appears that there are two large districts in the northeastern and southeastern portions of the State in which this expenditure exceeds 40 cents per acre, and that there are twenty-nine counties, chiefly in the northeastern and central portions, where it is less than 5 cents.

For a more detailed study the State is divided into seven sections, and the percentage of area in wheat and the yield per acre are tabulated for each county in these several sections, together with the gain or loss in yield during the last decade and the cost of fertilizers per acre. A comparison of the yields in the different sections for the last decade with those for the sixties, when wheat culture (for the most part without fertilizers) had sunk to a low ebb, owing to exhaustion of the soil or unfavorable climatic conditions, is made in the following table:

Effect of fertilizers on yield of wheat.

Sections.	Yield per acre.		Increase per acre.	Cost of fertilizers per acre.
	1860–69.	1880–89.		
	Bushels.	*Bushels.*	*Bushels.*	
Northeastern	12.7	16.4	3.7	$1.34
North central	13.1	15.7	2.6	0.13
Northwestern	11.6	14.2	2.6	....
Eastern	10.5	13.5	3.0	0.20
Central	10.9	12.7	1.8	0.08
Southwestern	12.6	13.7	1.1	0.06
Southern	8.2	9.7	1.5	0.47

A more nearly correct idea of the trend of wheat production in Ohio may be obtained by comparing the yields of the different sections in two 20-year periods, although even in this case allowance must be made for the fact that the first period contains a series of abnormally low yields, and the second a like series of abnormally high yields.

Average yield of wheat in Ohio by 20-year periods.

Sections.	Yield per acre.		Increase.
	1850–69.	1870–89.	
	Bushels.	*Bushels.*	*Bushels.*
Northeastern	12.9	15.8	2.9
North-central	13.3	16.2	2.9
Northwestern	11.6	14.3	2.7
Eastern	10.8	12.8	2.0
Central	11.5	12.7	1.2
Western	13.2	14.3	1.1
Southwestern	13.4	13.0	—0.4
Southern	9.3	9.4	0.1

A glance at the geological map of Ohio shows three broad bands running across the State from north to south. That on the east embraces the coal measures, and extends across nearly one third of the State; then follows a narrower strip, underlaid with Waverly rocks and bordered by a narrow belt of Huron shales, while the western half of the State lies over limestones. * * *

In the following table is given the average yields per acre of each of these groups of counties for the 40 years under review and for each of the two 20-year periods, and the average increase in yield per acre during the last 20 years:

Yield of wheat per acre in Ohio by geological divisions.

Groups.	Forty years, 1850–89.	Twenty years, 1850–69.	Twenty years, 1870–89.	Increase or decrease (—).
Northern belt:	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Twelve limestone counties	13.5	12.1	15.0	2.9
Seven Waverly counties	14.6	12.9	16.3	3.4
Six coal counties	13.2	11.8	14.7	2.8
Middle belt:				
Eleven limestone counties	13.0	12.2	13.8	1.6
Four Waverly counties	11.8	11.2	12.4	1.2
Seven coal counties	11.2	10.5	12.0	1.5
Southern belt:				
Twelve limestone counties	11.8	12.1	11.6	—0.5
Three Waverly counties	9.9	9.5	10.4	0.9
Twelve coal counties	9.2	9.2	9.3	0.1

Within 20 years the area annually sown to wheat in Ohio has increased from an average of 1,800,000 acres during the eighth to 2,500,000 acres during the ninth decade. This area represents 12 per cent of the area in farms within the State, but several counties are sowing annually 18 to 20 and even 25 per cent of their farm land to wheat. * * * The time may come when the average of the entire State will equal the present average of Summit County, which means a total average production of about 60 million bushels, or bread for 12 million mouths. * * *

It would seem that the profitable culture of wheat on the steep hillsides of southern Ohio is a hopeless undertaking; that the great problem before the wheat grower of the central belt of counties is winterkilling—a problem which may be partially solved by underdrainage and the intelligent use of clover and manures; and that in the northern counties climatic influences are more generally favorable to wheat culture than elsewhere in the State.

These statistics indicate that the wheat crops of Ohio have been slightly increased by the use of commercial fertilizers, but it appears that the average cost of this increase has equaled its market value, and that a general improvement in the methods of agriculture has contributed more largely to the increase of Ohio's wheat crops than the use of purchased fertility.

It would seem that the total area under wheat might be considerably enlarged and at the same time more closely restricted to lands adapted to tillage, and that the yield per acre may be so increased that the total product shall reach double the quantity now annually produced.

Rhode Island Station, Third Annual Report, 1890 (pp. 196).

REPORT OF DIRECTOR, C. O. FLAGG, B. S. (pp. 8–30).—The report includes plans and descriptions of the barn and sheds of the station, and of the stable fittings, including four kinds of cattle stanchions which have been tried; an account of field experiments with rye, oats, corn, and potatoes; and a list of donations.

Experiments with rye (pp. 13–15).—Rye was grown upon land in which crops of buckwheat and of oats and rye had been plowed the previous year, and to which muriate and sulphate of potash, seaweed, stable manure, and "mixed chemicals" were each applied separately. The tabulated results show the largest yields of grain to have been with stable manure and with seaweed. "We believe that with a good press for baling the straw, rye can be profitably grown in this section of the State."

Experiments with oats (pp. 15–17).—These were on 9 fourth-acre plats, 4 of which received 233.75 pounds each of Earle's Horsefoot Guano, costing $14.02; 3 an equal value of a mixed fertilizer composed of muriate of potash, nitrate of soda, bone superphosphate, fine ground bone, tankage, and ammonium sulphate; and 2 remained unmanured. "The mixed fertilizer at the same cost, furnished approximately 11.5 pounds more of phosphoric acid, 29.6 pounds more of nitrogen, and an equal amount of potash, allowing that the guano contained the full amount of the higher guaranty which commercial fertilizers seldom reach." Oats were sown broadcast on 6 plats and drilled in on 3 plats. The plats were overrun with charlock, which was pulled up, but the crop was considerably injured. According to the results, as tabulated, the drilled plats yielded about 11 per cent more grain and straw than those sown broadcast, and under like conditions the "mixed chemicals at the same cost gave 34.6 per cent more grain and 13.7 per cent more straw than Earle's Horsefoot Guano."

Experiments with corn (pp. 18–23).—The yields of corn in 1889 and 1890 are tabulated for 17 tenth-acre plats manured with various combinations of barnyard manure, seaweed, and chemicals. The corn was planted in hills 3 feet apart each way. The indications were "that the soil is very deficient in phosphoric acid and that unless that element is supplied the expenditure of money for other fertilizing elements is a positive waste. The same money value of stable manure produces better results than seaweed."

Experiments with potatoes (pp. 23–27).—Potatoes were raised on 24 fortieth-acre plats on which were applied ammonium sulphate, nitrate of soda, ground bone, and barnyard manure, singly and in various

combinations with each other and with boneblack, sulphate of potash, and gypsum. The yields are tabulated. The 3 unmanured plats, 1 of which had received seaweed the year previous, yielded 32, 63, and 17 bushels per acre respectively, and there were other indications of unevenness of the soil in fertility. The largest yields were where barnyard manure was used, but considering the cost the results were quite favorable to a mixture of 400 pounds each of muriate of potash and boneblack and 200 pounds nitrate of soda. There were indications that the soil needed phosphoric acid for this crop.

REPORT OF CHEMIST, H. J. WHEELER, PH. D. (pp. 31–107).

General analyses of fertilizing materials, etc. (pp. 33–39).—Analyses of muriate of potash, dissolved boneblack, dissolved bone, ground bone, cotton waste, wool waste, wood ashes, sewage waters, well water, and a so-called "dyestuff," which proved to be only linseed meal.

Coöperative field experiments with fertilizers on Indian corn (pp. 39–107).—During 1890 the station superintended a series of coöperative experiments with fertilizers for corn which were carried out on ten different farms within the State, besides the station farm Each experiment included 20 twentieth-acre plats on which nitrate of soda 150 pounds, dissolved boneblack 350 pounds, and muriate of potash 150 pounds per acre were used singly, two by two, and all three together; and a mixture of the above amounts of boneblack and muriate of potash was used with nitrate of soda 150, 300, and 450 pounds, with ammonium sulphate 112, 224, and 336 pounds, and with dried blood 220, 440, and 660 pounds, respectively. Two plats remained unmanured. Where possible, unmanured strips were left between the plats. The seed and fertilizers were furnished by the station. The yields of the hard and soft corn and stover and the financial results are tabulated for ten experiments, the other experiment being omitted on account of errors. The general indications of the experiments are summarized by the author as follows:

The experiments show that there existed a wide variation in the fertility of the soils, and that cases of one-sided exhaustion were not of uncommon occurrence.

In four cases at least, potash appeared most deficient, and it is interesting to observe that the two most marked cases of a deficiency of phosphoric acid were upon old pastures.

In one or two instances the application of nitrogen, even in small quantities, resulted in little or no profit, and in general its application in large quantities, though it in some measure increased the crop, resulted in financial loss. Nitrogen proved most profitable upon soils with little sod and humus, *i. e.* light, sandy or gravelly loams.

Taking all the experiments into consideration, nitrogen in the form of nitrate of soda was more certain to give fair returns than in either of the other forms. Its lesser cost is also an additional argument in its favor.

The sulphate of ammonia gave, in one or two instances, better returns than nitrate of soda, though in two cases at least the period of growth was prolonged by its use, which may perhaps have been due to delayed nitrification. In one instance the sulphate nitrogen appears not only not to have become available to the plant, but to have had a decidedly injurious effect, for it more than neutralized the otherwise

good effect of the potash and phosphoric acid with which it was applied. The greater the application of the sulphate, the more disastrous were the results.

On the whole, nitrogen in the form of dried blood proved inferior to either of the other forms.

REPORT OF HORTICULTURIST, L. F. KINNEY, B. S. (pp. 108–162, plates 5).—The facilities for work in horticulture were materially increased in 1890. "A collection of dried specimens of the native and introduced grasses of the State has been prepared, and numerous additions have been made to the collection of vegetable and noxious weed seeds." A list of the varieties of large and small fruits planted was given in Bulletin No. 7 of the station (see Experiment Station Record, vol. II, p. 295). This report contains details of experiments with potatoes, parsnips, beans, lawn grasses, and new varieties of fruits and vegetables.

Potatoes, equal weights of seed per row (pp. 109–113).—This was in continuation of an experiment reported in Bulletin No. 5 and the Annual Report of the station for 1889 (see Experiment Station Record, vol. I, p. 297, and vol. II, p. 423). In 1890, 30 varieties were planted, each in one row 50 feet long. The rows were 3 feet apart. Each row was divided into three equal sections, and equal weights of one-eye and two-eye pieces and whole tubers were planted in the several sections. The results are reported in detail in two tables, together with the following summary:

	Section A.—Single-eye pieces, 9 inches apart.			Section B.—Two-eye pieces, 18 inches apart.			Section C.—Medium-sized whole potatoes, 36 inches apart.		
	Average number of tubers formed by each variety.	Average weight of tubers.	Average yield per acre.	Average number of tubers formed by each variety.	Average weight of tubers.	Average yield per acre.	Average number of tubers formed by each variety.	Average weight of tubers.	Average yield per acre.
		Ounces.	*Bush.*		*Ounces.*	*Bush.*		*Ounces.*	*Bush.*
Merchantable	61.0	4.6	248.24	65.5	4.9	279.18	62.8	4.9	268.83
Small	45.4	1.3	56.34	47.9	1.4	57.73	46.8	1.3	58.04
Total	106.4	3.2	304.58	113.4	3.4	336.91	109.6	3.3	326.87

Potatoes, equal weight of seed per hill (pp. 114–121).—Equal weights of one-eye and two-eye pieces and medium-sized and large whole tubers were planted in hills 9, 18, and 36 inches apart. Bliss Triumph, Thorburn, and Weld Early were the varieties used. Details are given in tables. The yield was largest where whole tubers were planted, but the single-eye pieces produced the largest per cent of merchantable tubers. When the tubers or cuttings were of equal size the yield was largest from the hills 9 inches apart; the average weight of individual tubers was greatest from the hills 9 inches apart.

Potatoes, test of varieties (pp. 122–136).—Descriptive notes and tabulated record of yields for 145 varieties. The following are considered most desirable for Rhode Island: Bliss Triumph, Brownell Winner,

Champlain, Charles Downing, Early Beauty of Hebron, Early Puritan, Early Vermont, Green Mountain, Thorburn, and Victory. In this test the largest yields were obtained with White Seedling, Victory, Alexander Prolific, Cambridge Prolific, Jones Prize-Taker, White Rose, Charles Downing, and Bonanza.

Potato rot (pp. 137–152).—A brief account of the disease caused by *Phytophthora infestans*, taken from a paper by F. Lamson-Scribner, B. S., and a detailed record of spraying experiments with Bordeaux mixture. The first application was made July 12. One plat was sprayed five times during the season, 2 others three times, and 1 remained untreated. The results favored spraying five times. The article is illustrated with five plates.

Parsnips, ridge vs. flat cultivation (pp. 152, 153).

> The plat where the experiment was conducted was prepared for planting as evenly as possible, with the exception that on one half of the piece ridges were raised about 8 inches above the surface by turning two furrows together, the soil on the sides and tops being smoothed off and packed together with a spade. The extra labor required in preparing the ridges was fully repaid in the care of the crop during the summer, but, with the exception of a slight reduction in the per cent of branched specimens, no advantage resulted in our trial of the ridge system over the more common method of flat cultivation.

Details are given in tables.

Beans, fertilizer experiment (pp. 154, 155).—Dissolved boneblack, sulphate of potash, muriate of potash, sulphate of ammonia, and nitrate of soda were applied singly and compared with no manure on 12 varieties of bush beans. The yields, as tabulated, indicate that the largest increase was caused by dissolved boneblack, with sulphate of potash second and muriate of potash third. The increase from the nitrogenous fertilizers was not sufficient to make their use profitable.

Lawn grasses (p. 156).—A brief account of an experiment in which Rhode Island bent grass (*Agrostis canina*) and Kentucky blue grass (*Poa pratensis*) were each planted alone and together with white clover. Early in the season the clover "added density to the forming sward, but later the growth was not so even where clover was sown." Rhode Island bent made a better growth than the blue grass.

New varieties of fruits and vegetables (pp. 157–162).—Brief descriptive notes on a few varieties of strawberries, beans, and cauliflowers, and on a novelty called the "garden lemon," which resembles a small muskmelon.

METEOROLOGICAL RECORD, L. F. KINNEY, B. S. (pp. 163–169).—A tabulated record of daily observations of temperature, rainfall, and barometric pressure. The yearly summary is as follows: *Pressure* (inches).—Mean 29.99. *Air temperature* (degrees F.).—Mean 48.7. *Precipitation* (inches).—Total 55.17.

REPORT OF APIARIST, S. CUSHMAN (pp. 170–175).—A brief account of the work in this line, with references to experiments reported in

Bulletins Nos. 7 and 9 of the station (see Experiment Station Record, vol. II, pp. 295 and 660).

REPORT OF TREASURER (pp. 176–178).—This is for the fiscal year ending June 30, 1890.

Rhode Island Station, Bulletin No. 12, August, 1891 (pp. 8).

COMMERCIAL FERTILIZERS, H. J. WHEELER, PH. D., AND B. L. HARTWELL, B. S. (pp. 151–158).—Analyses of 25 samples of commercial fertilizers collected under the State inspection in 1890, with comments.

South Carolina Station, Bulletin No. 2 (New Series), July, 1891 (pp. 112).

COTTON, EXPERIMENTS WITH VARIETIES AND WITH FERTILIZERS, J. M. McBRYDE, PH. D.—The experiments with cotton carried on at the experimental farms of the station during 1888 and 1889 at Spartanburg and Darlington were continued in 1890 with very little change. The results for 1888 and 1889 were reported in the Annual Reports of the station for those years (see Experiment Station Bulletin No. 2, part II, p. 152, and Experiment Station Record, vol. III, p. 322). This bulletin records the results for 1890 and the average results for the 3 years.

Every test was duplicated, its two plats being as widely separated from each other as the limits of the field would permit. The same experiments were carried on at both farms. These farms were situated in different sections of the State and were very unlike in their climatic surroundings and the character of their soils. They agreed however in one respect, the poverty of their soils. Their fertility had been greatly reduced by long years of wasteful tillage. * * * The same experiments were continued from year to year. * * *

The combined averages of the two farms for the 3 years cover three favorable and three unfavorable seasons and are entitled to great weight as representing a fair average of seasons.

Varieties of cotton (pp. 8–29).—In 1890, 14 varieties were tested at Spartanburg and 18 at Darlington. During the 3 years "the varieties tested amounted to 50."

Eight varieties were tested at both farms for 3 years. Texas Wood gave the best average at Spartanburg (322 pounds lint per acre), the second best average at Darlington (346 pounds), and the best combined average for the two farms (334 pounds). Peterkin gave the second best average at Spartanburg (399 pounds), the best average at Darlington (353 pounds), and the second best combined average (326 pounds). Truitt gave the fourth best average at Spartanburg (280 pounds), the third best at Darlington (327 pounds), and the third best combined average (303 pounds). * * * It appears that there is a close connection between the yield and the percentage of lint, and that the long staple varieties do not make up by any superior productiveness for their low percentages of lint. * * *

When classified according to their percentages of lint, it is probable that the majority of the so-called varieties of cotton cultivated in this State can be divided into three groups, two of which appear to correspond somewhat closely with two clearly defined old types, the short staple cotton and the long staple—by some regarded

as well-established varieties or even subspecies, by others as distinct species. The kinds referred to the remaining group may possibly be different strains of a hybrid of these two types. These groups may, therefore, for convenience, be called the long staple, the short staple, and the Rio Grande. The first will include strains or subvarieties giving about 31 per cent of lint or under, its normal being about 30 per cent; the second, those giving about 32 to 34 per cent, its normal being about 32 per cent; and the third, those giving about 36 per cent or upwards, its normal being about 37¾ per cent.

The long staple group, with the lowest percentage of lint, shows the smallest average yield of lint.

The short staple group, with a medium percentage of lint, shows a somewhat better average yield of lint than the long staple.

The Rio Grande group, with the highest percentage of lint, shows the highest average yield of lint. * * *

It seems to be established that thorough cultivation and careful selection of seed for a number of years will improve the productiveness of any variety or increase its percentage of lint. The limits of such possible improvement have not as yet been determined.

Fertilizers for cotton (pp. 30–91).—The studies in this direction included special nitrogen, phosphoric acid, and potash experiments; experiments as to the amounts of these ingredients required; as to the forms in which they are best applied; the best time for applying nitrate of soda; methods of applying fertilizers (drilling *vs.* sowing broadcast); and tests with marl and copperas. The results at the two farms for 3 years seem to the author to warrant the following general conclusions:

(1) Cotton requires nitrogen, phosphoric acid, and potash.

(2) Of the three, phosphoric acid is relatively the most important and controls the action of the other two. It can be used alone with some advantage to the crop, but much more effectively in connection with potash and nitrogen.

(3) Nitrogen is relatively more important than potash. It can be advantageously used only in combination with phosphoric acid or phosphoric acid and potash.

(4) Potash, like nitrogen, is of little value to cotton when applied separately; it must be combined with the other constituents.

(5) Expressed in terms of the [recent] analyses, the proportion and amounts of nitrogen, phosphoric acid, and potash required are as follows: Between ⅔ and ¾ nitrogen, about 4½ phosphoric acid, between ⅓ and ½ potash. * * * In other words, the required proportion is: 1 nitrogen, 2½ phosphoric acid, and ¾ potash; and the amounts called for by a crop yielding 300 pounds of lint per acre are, nitrogen 20 pounds, phosphoric acid 50 pounds, potash 15 pounds.

(6) The amount of phosphoric acid determines the amount of nitrogen and potash. With a given amount of the first, only certain amounts of the two last can be pofitably used.

(7) The amount of phosphoric acid and proportionate amounts of nitrogen and potash can not be indefinitely increased with the expectation of obtaining a corresponding increase in the crop. The gain in crop does not keep pace with increase of fertilizers, and a point is speedily reached beyond which this gain is not sufficient to meet the additional cost of the heavier applications. The soil can not be profitably forced; the application of fertilizers must be regulated by its mechanical as well as chemical condition.

(8) Potash can be as effectively supplied by muriate of potash or kainit as it can by sulphate of potash. This is opposed to the view which regards the chlorides of the two former as injurious, and therefore holds that the higher-priced potash of the

latter is to be preferred. Since equivalent amounts of potash in the three kinds are of equal value to cotton, the choice of the farmer must be determined by their relative cost. At present prices, especially when the matter of freight is considered, the potash of the muriate is the cheapest.

(9) Phosphoric acid is of value to cotton in proportion to its solubility, hence the several kinds of phosphatic manures can not be indifferently employed. Preference must be given to acid phosphates containing considerable percentages of soluble phosphoric acid. Insoluble phosphoric acid in slag, floats, or marl is of little direct value to the crop upon which it is applied, and even granting that its effects in the soil may be lasting, they are not, in the long run, sufficiently pronounced to meet the interest on the capital invested in the application. Speculating in futures is not a safe business. According to the best agricultural experience of our day, the better plan is to use only such fertilizers as will meet the demands of the crop upon which they are applied.

(10) Inorganic, organic, and mixed nitrogen are of very nearly equal value to cotton. The slight difference is in favor of the last two.

Stable manure containing organic nitrogen is the best fertilizer of its class and lasting or cumulative in its effects.

The organic nitrogen of stable manure, to the amount of 50 per cent, can be fully replaced by the inorganic nitrogen of nitrate of soda.

Of the commercial forms of nitrogen among which the farmer has to choose, the organic nitrogen of dried blood is perhaps the best, and at present prices the cheapest. As between cotton-seed meal and cotton seed there is a slight difference in favor of the former. Whole cotton seed is as efficacious as ground cotton seed.

Inorganic nitrogen in nitrate of soda is about as valuable to cotton as organic nitrogen in cotton seed or cotton-seed meal.

(11) Used alone or in combination with commercial fertilizers, the lime of marl is of no direct value to cotton. Mixed with acid phosphate, it may even act injuriously by retarding or preventing its solution in the soils. Applied upon leguminous crops, such as cowpeas, vetch, etc., which are to be turned under as a preparation for cotton, its indirect value is great.

(12) Applications of copperas are without effect upon cotton.

(13) Nitrate of soda should generally be applied along with the other fertilizers at the time of planting.

(14) Fertilizers may be indifferently drilled or sown broadcast where they are liberally applied, but drilling is to be preferred where small amounts are employed. * * *

These conclusions apply only to soils similar in character and condition to those of the two farms, which, however, are representatives of two large classes. Our tests covered a period of 3 years. A longer period might possibly have given different results.

Twelve different formulas for fertilizers for cotton are given, together with statements of the composition of some of the more common fertilizing materials, and of the equivalent amounts of ingredients furnished by different materials.

Modes of planting cotton (pp. 92–110).—Under this head are included a comparison on both farms for 3 years of drilling and checking, at different distances; trials of topping cotton; effects of continuous cropping with cotton; effects of oats grown along with cotton; and cowpeas as a fertilizer for cotton. Briefly considered, the results seem to imply that "as far as our tests go one method of planting will give about the same results as the other. Checking, however, saves hand labor and gives the farmer more command over his crop. It is

somewhat cheaper than drilling." In a 3 years' test at Spartanburg in which 2 plats were topped and 2 left untopped, "topping was of no benefit whatever to the crop."

To "protect the soil during the winter and supply it with vegetable matter when plowed under in the spring," oats were sown at both farms in the fall, between the rows of cotton, on fertilized and unfertilized plats and on plats to which the cotton seed was returned each year. From the results for 3 years the indications were that the oats were of no benefit to the soil.

For 3 years, trials were made at both farms of sowing cowpeas between the rows of cotton on fertilized and unfertilized plats, and on plats to which the cotton seed was returned each year. At Spartanburg "in consequence of the character and condition of the land and the unfavorable seasons, the pea crop was a comparative failure every year." At Darlington, however, both the fertilized and the unfertilized plats where peas were sown gave decidedly larger yields than those without peas; and on the plats where the cotton seed was returned there was a slight increase with peas. At Darlington in a rotation experiment in growing cotton in 1888, peas in 1889, and cotton again in 1890, "the pea crop of 1889, in connection with the marl of the other years, increased the crop more than fivefold." Trials of replacing the nitrogenous fertilizers by a crop of cowpeas as green manure, gave results which, considering the cost, were very favorable to peas.

South Carolina Station, Bulletin No. 3 (New Series), October, 1891 (pp 16).

COMMERCIAL FERTILIZERS.—Analyses of 79 samples of commercial fertilizers, including bone, kainit, muriate of potash, nitrate of soda, dried blood, tankage, and fish scrap; and the text of the State laws relating to the inspection and sale of commercial fertilizers.

South Carolina Station, Bulletin No. 4 (New Series), December, 1891 (pp. 12).

FERTILIZERS ON WHEAT, J. F. DUGGAR, M. S. (pp. 3–10).—A test was made on 19 twentieth-acre plats, 3 of which remained unfertilized, the other 16 receiving kainit, superphosphate, ammonium sulphate, nitrate of soda, cotton seed, cotton-seed meal, and barnyard manure, singly and in a variety of combinations. The fertilizers were applied as top-dressings March 24. The land was very poor and it proved to be quite uneven, so that the results furnish no definite indications of the needs of the soil for this crop. For instance, the largest yield—14.17 bushels per acre—was with barnyard manure; but an adjoining plat receiving the same amount of this manure gave only 8.17 bushels. Kainit seemed not to affect the yield. Both nitrate of soda and sulphate of ammonia seemed to be effective. The yields are tabulated.

VARIETIES OF WHEAT AND OATS, J. F. DUGGAR, M. S. (pp. 10–12).—Notes on 5 varieties of wheat and 3 of oats.

South Dakota Station, Bulletin No. 25, June, 1891 (pp. 24).

GLANDERS, SCAB, AND BLACKLEG, C. A. CARY, D. V. M. (pp. 167–188).—An account of the symptoms, causes, and transmission of glanders, and brief descriptions of common and head scab and blackleg of sheep, with suggestions regarding treatment.

South Dakota Station, Bulletin No. 26, July, 1891 (pp. 18).

EXPERIMENTS IN HORTICULTURE, C. A. KEFFER, M. H.—This includes notes on strawberries, the sand cherry, plums, apples, and crab apples.

Strawberries (pp. 3–9).—The experiments thus far made indicate that, owing to dry weather in the autumn, relatively few flower buds are produced. In 1891 the station plantation produced at the rate of only 600 quarts of berries per acre. The most promising of the older varieties were Crescent, Windsor, Manchester, Mount Vernon, and Glendale. The only new varieties which fruited in 1891 were Alpha, Pearl, Bomba, Jessie, Parker Earle, Woodruff, and Mammoth.

Sand cherry (pp. 10, 11).—The sand cherry (*Prunus pumila*) is a native of the Dakotas. It produces fruit the third year from the seed and seems able to endure the dry and cold weather of this region. It is believed it will be of service in producing a variety of cherries suited to the Northwest.

Plums (pp. 12–15).—Of the 11 varieties of plum trees which fruited in 1891, De Soto, Harrison Peach, Rare Ripe, and Wyant are thought to be adapted to the region of the station. Several varieties of wild plums native to the Bad Lands of South Dakota and a seedling variety from northern Iowa are regarded as worthy of trial.

Apples and crab apples (pp. 16–18).—Notes on the pruning and cultivation of the station orchard. Gideon No. 25 and Dartt Greenwood, varieties of crab apples which have fruited at the station, are considered promising.

Tennessee Station, Bulletin Vol. IV, No. 5, December, 1891 (pp. 27).

CHEMICAL STUDY OF THE COTTON PLANT, J. B. MCBRYDE, C. E. (pp. 120–135).—The analyses here reported were made by the author at the South Carolina Station during 1889 and 1890, but have not hitherto been published. They include separate analyses of the whole plant, lint, seed, bolls ("the empty burr or capsule after the seed has been removed"), leaves, stem, and roots; of parts of the seed (kernels and hulls), cotton-seed meal, and cotton-hull ashes; a determination of the relative weight of different parts of the plant; and a comparison of the fertilizing constituents contained in crops of cotton yielding 300 pounds of lint, of corn yielding 20 bushels, and of oats yielding 30 bushels of grain per acre. The analysis of the whole plant (six average plants with roots) and parts of the plant are given as follows:

Analysis of the cotton plant (whole plant).

	Air-dry plant.	Ash.
	Per cent.	*Per cent.*
Moisture at 100° C	7.360	....
Crude ash	5.810	....
Nitrogen	1.460	....
Phosphoric acid	0.439	7.55
Potassium oxide	1.324	22.79
Sodium oxide	0 106	1.82
Calcium oxide	1.416	24.38
Magnesium oxide	0.517	8.90
Sulphuric acid	0.199	3.43
Insoluble matter	0.433	7.46

Analysis of parts of the cotton plant.

	Lint.				Seed.				Bolls.			
	Crop of 1889.		Crop of 1890.		Whole seed.		Water-free kernels.	Water-free hulls.	Crop of 1889.		Crop of 1890.	
	Air-dry.	Ash.	Air-dry.	Ash.	Air-dry.	Ash.			Air-dry.	Ash.	Air-dry.	Ash.
	Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
Moisture at 100° C	6.72	......	6.77	......	7.04	......	......	......	9.47	......	14.36	......
Crude ash	1.50	......	1.80	......	3.285	......	......	......	7.65	......	7.03	......
Nitrogen	0.28	......	0.200	......	3.07	......	5.31	0.39	1.36	......	0.865	......
Phosphoric acid	0.066	4.41	0.053	2.94	1.019	31.01	1.840	0.102	0.401	5.245	0.170	2.425
Potassium oxide	0.637	42.47	0.848	47.10	1.166	35.50	1.216	1.454	2.905	37.93	3.226	45.895
Sodium oxide	0.026	1.76	0.027	1.51	0.019	0.57	......	......	0.045	0.59	0.045	0.64
Calcium oxide	0.155	10.36	0.149	8.30	0.187	5.68	0.175	0.182	1.092	14.28	0.775	11.03
Magnesium oxide	0.111	7.41	0.161	8.96	0.499	15.19	0.883	0.390	0.291	3.81	0.209	2.97
Sulphuric acid	0.086	5.71	0.090	5.01	0.128	3.90	0.126	0.105	0.558	7.30	0.315	4.48
Insoluble matter	0.023	1.56	0.028	1.555	0.023	0.69	0.580	0.042	0.269	3.52	0.305	4.34

	Leaves.				Stem.				Roots.			
	Crop of 1889.		Crop of 1890.		Crop of 1889.		Crop of 1890.		Crop of 1889.		Crop of 1890.	
	Air-dry.	Ash.	Air-dry.	Ash.	Air-dry.	Ash.	Air-dry.	Ash.	Air-dry.	Ash.	Air-dry.	Ash.
	Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
Moisture at 100° C	9.50	......	12.14	......	8.41	......	11.71	......	7.65	......	6.93	......
Crude ash	16.42	......	12.05	......	3.925	......	4.23	......	3.310	......	3.36	......
Nitrogen	2.367	......	2.451	......	0.830	......	0.739	......	0.707	......	0.591	......
Phosphoric acid	0.456	2.78	0.422	3.50	0.197	5.01	0.173	4.10	0.169	5.10	0.135	4.02
Potassium oxide	0.828	5.04	1.327	11.01	0.915	23.32	1.453	34.35	0.861	26.00	1.342	39.94
Sodium oxide	0.366	2.22	0.206	1.71	0.106	2.69	0.091	2.14	0.162	4.88	0.133	3.97
Calcium oxide	7.082	43.13	4.096	33.99	1.055	26.87	0.623	14.72	0.696	21.04	0.386	11.49
Magnesium oxide	1.260	7.68	0.762	6.32	0.431	10.98	0.300	7.10	0.336	10.16	0.301	8.97
Sulphuric acid	0.842	5.13	0.376	3.12	0.140	3.57	0.082	1.95	0.126	3.82	0.100	2.97
Insoluble matter	0.928	5.65	1.200	10.04	0.069	1.76	0.174	4.11	0.205	6.19	0.233	6.92

[The first sample of lint was machine ginned, the second] was separated from the seed by hand in the laboratory. Both were fair samples of upland cotton. * * *

Both the insoluble residue and crude ash in these two samples are probably a little higher than the true amount on account of the dust blown into the lint by the wind, which it was almost impossible to remove completely. The differences in the phosphoric acid and potash are undoubtedly due to variations in the two samples, which were grown in different seasons and on different soils. Duplicate analyses verified these results.

The seed was carefully selected, being a mixture of several samples of seed from which the lint had been separated by hand. In this manner a sample almost entirely free from dust and sand was obtained. * * *

The analyses of the kernels and hulls are taken from the Annual Report of the North Carolina Station for 1882. The samples analyzed were carefully separated by hand. * * *

[Analyses of the hull ashes showed a] marked difference between the commercial sample of hull ashes and the sample burned in the laboratory, due to the intense heat of the furnaces of the mills, which volatilizes part of the potash [and to admixtures. While the commercial hull ash contained 26.88 per cent of potassium oxide, the sample carefully burned in the laboratory contained 48.75 per cent].

Next to the seed the leaves contain more nitrogen than any other portion of the plant. They also contain a moderate amount of phosphoric acid and potash. The amount of lime and magnesia is striking, the percentages of each of these constituents being higher than in any other part of the plant. The leaves show also the highest per cent of crude ash. * * *

Although not as rich in fertilizing constituents as the other parts of the plant, the stem is by no means valueless, as it contains nearly 1 per cent of nitrogen, besides phosphoric acid and potash. The wastefulness of burning the stems can readily be seen. * * *

In their chemical constituents the roots closely resemble the stem. The variations between the percentages of the individual constituents of the two samples of the stem, and the corresponding variations between the percentages of the two samples of roots are almost identical. * * *

In determining the relation of parts of the plant "350 bolls, containing lint and seed, were carefully gathered and weighed. The seed cotton was then separated from the bolls and each part weighed separately. * * * The weight of the leaves and stems was determined by weighing these parts from twenty odd plants of all sizes grown in different soils and in different seasons (1889 and 1890)." The roots of a number of plants of all sizes were separated from the soil by hand, washed, dried, and weighed. The relation found was as follows:

Relative weight of parts of the cotton plant.

	In water-free plant.		
	Weight in ounces.	Weight in grams.	Per cent.
Lint	0.615	17.45	10.56
Seed	1.343	38.07	23.03
Bolls	0.829	23.49	14.21
Leaves	1.181	33.48	20.25
Stems	1.350	38.26	23.15
Roots	0.513	14.55	8.80
Total	5.831	165.30	100.00

The average number of bolls per plant was found to be 13; the average weight of one boll with lint and seed was 6.7 grams; the average weight of a cotton plant, as computed in the table, is 165 grams; the average of some twenty plants, carefully weighed, was 168 grams; the percentage of lint in seed cotton was 31.44 per cent.

The calculated amount of fertilizing ingredients contained in a crop of cotton (air-dry) yielding 300 pounds of lint per acre is given as follows:

Fertilizing constituents contained in a crop of cotton yielding 300 pounds of lint per acre.

	Pounds per acre.						
	In 300 pounds lint.	In 654 pounds seed.	In 404 pounds bolls.	In 575 pounds leaves.	In 658 pounds stems.	In 250 pounds roots.	In 2,841 pounds total crop.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Nitrogen	0.72	20.08	4.50	13.85	5.17	1.62	45.94
Phosphoric acid	0.18	6.66	1.14	2.57	1.22	0.38	12.15
Potassium oxide	2.22	7.63	12.20	6.57	7.74	2.75	39.11

In addition to the data mentioned above, previous studies of the composition of the cotton plant by Jackson, White, Pendleton, and Ville are referred to, and brief summaries given of their results, together with an abstract from the Tenth U. S. Census on the yield of oil and by-products from cotton seed at oil mills. These latter data, expressed in per cent of the whole seed as separated at the mills, and the "actual" percentage of parts of the seed are reported as follows:

	Separated at mills.	Actual proportion.
	Per cent.	*Per cent.*
Meal	35.5	30.0
Oil	12.5	20.0
Hulls	48.9	40.0
Lint	1.1	10.0
Total	100.0	100.0

"The figures [in the last column] represent very closely the actual percentages in the seed. Those for kernels and hulls were taken from the Annual Report of the North Carolina Station for 1881, and are the averages of a large number of weighings. The percentage of lint is taken from the Annual Report of the South Carolina Station for 1888, and the percentage of oil is the average of a number of tests."

Field tests of fertilizers on cotton, J. B. McBryde, C. E. (pp. 135–141).—This consists of a summary of the results of experiments at the South Carolina Station, reported in Bulletin No. 2 (new series) of that station (see Experiment Station Record, vol. III, p. 534), on fertilizers for cotton, and several formulas for fertilizer mixtures based on these results.

Feeding value of the cotton plant and its parts, J. B. McBryde, C. E. (pp. 141–145).—Analyses with reference to food constituents are given of the whole and parts of the cotton plant and seed, and of the plant after picking, together with an analysis of dung from animals fed cotton-seed meal and hulls.

Food ingredients in the cotton plant and its parts.

	Lint.	Seed.	Bolls.	Leaves.	Stems.	Roots.	Whole plant.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture at 100° C	6.74	7.04	11.92	10.82	10.06	7.29	7.36
Dry matter	93.26	92.96	88.08	89.18	89.94	92.71	92.64
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of dry matter:							
Crude ash	1.77	3.53	8.33	15.93	4.54	3.60	6.27
Crude cellulose	89.75	24.13	36.90	11.26	50.18	52.39	33.40
Crude fat	0.65	23.26	1.57	7.31	0.90	2.35	4.23
Crude protein	1.61	20.61	7.84	16.89	5.45	4.39	9.85
Nitrogen-free extract	6.22	28.47	45.36	48.61	38.93	37.27	46.25
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The following table shows the composition of the plant after picking, both when gathered "as soon after picking as possible" and "late in the season after the last picking was over," as compared with that of oat straw and corn stover (analyses from other sources).

Cotton plant after picking as compared with oat straw and corn stover.

	Cotton plant after picking.		Oat straw.	Corn stover.
	Gathered early.*	Gathered late.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture at 100° C	6.51	10.76	8.16	18.92
Dry matter	93.49	89.24	91.84	81.08
	100.00	100.00	100.00	100.00
Analysis of dry matter:				
Crude ash	5.67	5.98	5.78	5.03
Crude cellulose	37.79	45.13	39.13	32.02
Crude fat	2.80	1.16	2.58	1.65
Crude protein	6.48	6.36	4.17	7.92
Nitrogen-free extract	47.26	41.37	48.34	53.38
	100.00	100.00	100.00	100.00

* North Carolina Station Annual Report for 1882.

The agreement between the two samples of the plant after picking is quite close—closer in fact than could have been expected. The North Carolina sample shows, however, higher value as a food. As cotton is not generally picked out until late in December, it would be impossible to cut the crop sooner; consequently there would only remain the stalks with part of the bolls, some of them unopened. The leaves and part of the bolls would drop off earlier in the fall. The figures in the first column will approximately represent the plant at this stage. But even taken at so late a period, the value of the cotton plant ground up as a feeding stuff agrees closely with the values of oat straw and corn stover. * * * The most serious objection to its use as a feeding stuff would be the cost of gathering and grinding, for unless ground and mixed with meal or grain of some kind it would be almost valueless.

The table below shows the composition of the kernels and hulls of the seed carefully separated by hand, taken from the Annual Report of the North Carolina Station for 1882, and of the commercial cotton-seed meal and hulls.

Analysis of parts of cotton seed.

	Hand-separated seed.		Machine-hulled seed.	
	Kernels.	Hulls.	Meal.	Hulls.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture at 100° C	6.27	9.16	7.47	11.30
Dry matter	93.73	90.84	92.53	88.70
	100.00	100.00	100.00	100.00
Analysis of dry matter:				
Crude ash	4.30	2.51	7.60	3.30
Crude cellulose	4.67	51.87	4.90	43.85
Crude fat	39.00	0.64	10.01	2.35
Crude protein	31.21	2.41	51.12	5.19
Nitrogen-free extract	20.82	42.57	26.37	45.31
	100.00	100.00	100.00	100.00

The difference between the composition of the hand-separated and machine-hulled products "is due to the fact that when the seed is hulled at the mills a small part of the kernel adheres to the hulls, thereby increasing their value as a food. The analyses, which agree very well with the average of a large number of analyses made elsewhere, show that the hulls have a comparatively low nutritive value. They rank along with straw and corn stover in their percentages of the most valuable nutrients (protein, fat, etc.)."

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF STATISTICS.

Report No. 91 (new series), December, 1891 (pp. 637-698).—This includes articles on meteorology in relation to the crops of 1891, statistics of the crops of the year, farm prices, condition of growing crops, distribution of spring and winter wheat, cotton imports of the United States, the canning industry, agriculture in Uruguay and in the Guianas, European crop report for December, and rates of transportation companies.

Meteorology in relation to the crops of 1891.—Summaries of the temperature and precipitation during the growing season of 1891 are given, and the relation of the conditions thus shown to the yields of different crops is discussed with the aid of diagrams. The following table shows the departures both in temperature and rainfall from the normal for each month of the year ending with October, 1891, in four of the principal agricultural regions of the United States:

Months.	Middle Atlantic States.		Western Gulf States.		Ohio Valley and Tennessee.		Upper Mississippi Valley.	
	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.
1890.	*Degrees.*	*Inches.*	*Degrees.*	*Inches.*	*Degrees.*	*Inches.*	*Degrees.*	*Inches.*
October	—1.3	+1.77	—1.4	+0.57	—1.7	+0.82	—1.2	+0.26
November	+1.2	—2.73	+2.8	—0.87	+4.6	—1.49	+3.7	—0.51
December	—2.9	+0.53	+2.9	—1.91	+1.1	—0.42	+3.9	—1.38
1891.								
January	+2.9	+1.08	+1.7	+2.38	+4.4	—0.08	+9.3	—0.01
February	+4.4	+1.51	+1.2	—1.45	+3.4	+1.89	+0.2	—0.41
March	—2.2	+2.10	—5.2	—0.34	—3.6	+2.03	—5.4	+0.36
April	+2.6	—1.11	—0.9	—0.15	+2.1	—1.90	+2.0	—0.34
May	—1.7	—0.34	—2.7	—3.04	—2.8	—2.04	—1.6	—1.90
June	+0.2	—1.15	+0.5	—1.20	+2.6	+0.13	+0.8	—0.83
July	—4.3	+2.20	—2.5	+1.40	—4.6	+0.80	—5.8	—0.80
August	+0.9	0.00	—1.8	—1.10	—0.8	—0.30	—1.3	+0.80
September	+2.9	—1.50	+0.5	—1.20	+2.6	—1.60	+5.4	—2.50
October	—2.7	+0.20	—1.7	—2.80	—1.8	—1.80	+0.1	—1.40

The relatively high temperature of April, with slightly deficient rainfall, gave excellent opportunity for careful preparation of the seed bed for spring crops and for the prosecution of seeding. During May the characteristics which marked the season began to be felt. With but two exceptions, trifling in their nature, there was a marked deficiency in temperature in every district in the country, while the rainfall was almost as generally below the usual supply for the month. Conditions very similar prevailed during the succeeding months of June, July, and August, with the exception that June was marked by a generally sufficient supply of rainfall. * * * The month of September, however, so far as temperature was concerned, was a complete reversal of the previous record of the season. The temperature rose very high, and as it was accompanied with less than the usual rainfall, it gave a month of hot forcing weather, crowding late crops to ripening and compensating for the somewhat unfavorable character of the previous portion of the season. This compensation was noticeably marked in the great corn belt. * * *

[A comparison of the meteorological peculiarities of 1890 and 1891 shows that] the condition of corn on the first of July was practically identical in the 2 years. It is always good at that date unless cold and wet spring weather has interfered with planting, germination, and early growth. Though maize can endure more heat and drouth than most other agricultural plants, the danger of long-continued absence of rainfall, especially in July and August, the season of development for this crop, is the greatest to which it is exposed. Note the sudden decline of condition in 1890, due mainly to drouth, as indicated by the report of the first of August. The August weather intensified the injury, while the favorable influences of September at least prevented further decline and led to slightly more hopeful views in the formulation of the local estimates of October. The record of 1891, in sharp contrast to that of 1890, commencing with quite moderate evidence of early growth, showed that the crop had endured the ordeal of deficient moisture and the fervent suns of July with a lowering of only two points, after which a steady improvement continued to October, and later through the autumn season so important in drying the grain and perfecting its quality. This has advanced a crop of medium status, in its germination and stalk growth, to a production above the average, or 27 bushels per acre, not the largest yield known, but one not often exceeded for the entire breadth. * * *

A noticeable and unusual peculiarity of the year is the almost universal occurrence of medium or large production. Ordinarily, a large yield of one crop is offset by a diminished product of another. The summer crops may be generally good, and the winter grains and grasses seriously injured by the severity of the winter.

Statistics of corn, wheat, and oats.—The following summary has been compiled from the tables given in the bulletin:

	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value per acre.
CORN.						
Average, 10 years, 1880 to 1889	*Bushels.* 1, 703, 443, 054	*Acres.* 70, 543, 457	$668, 942, 370	*Cents.* 39. 3	*Bushels.* 24. 1	$9. 48
Average, 10 years, 1870 to 1879	1, 184, 486, 954	43, 741, 331	504, 571, 048	42. 6	27. 1	11. 54
1890	1, 489, 970, 000	71, 970, 763	754, 433, 451	50. 6	20. 7	10. 48
1891	2, 060, 154, 000	76, 204, 515	836, 439, 228	40. 6	27. 0	10. 98
Total	3, 550, 124, 000	148, 175, 278	1, 590, 872, 679			
Average, 2 years, 1890 and 1891	1, 775, 062, 000	74, 087, 639	795, 436, 340	44. 8	24. 0	10. 74
WHEAT.						
Average, 10 years, 1880 to 1889	449, 695, 359	37, 279, 162	371, 809, 504	82. 7	12. 1	9. 97
Average, 10 years, 1870 to 1879	312, 152, 728	25, 187, 414	327, 407, 258	104. 9	12. 4	13. 00
1890	399, 262, 000	36, 087, 154	334, 773, 678	83. 8	11. 1	9. 28
1891	611, 780, 000	39, 916, 897	513, 472, 711	83. 9	15. 3	12. 86
Total	1, 011, 042, 000	76, 004, 051	848, 246, 389			
Average, 2 years, 1890 and 1891	505, 521, 000	38, 002, 026	424, 123, 195	83. 9	13. 3	11. 16
OATS.						
Average, 10 years, 1880 to 1889	584, 395, 839	21, 996, 376	180, 866, 412	30. 9	26. 6	8. 22
Average, 10 years, 1870 to 1879	314, 441, 178	11, 076, 822	111, 075, 223	35. 3	28. 4	10. 03
1890	523, 621, 000	26, 431, 369	222, 048, 486	42. 4	19. 8	8. 40
1891	738, 394, 000	25, 581, 861	232, 312, 267	31. 5	28. 9	9. 08
Total	1, 262, 015, 000	52, 013, 230	454, 360, 753			
Average, 2 years, 1890 and 1891	631, 007, 500	26, 006, 615	227, 180, 377	36. 0	24. 3	8. 74

Cotton imports of the United States.—"Our official trade records show that during the 10 years, from 1880 to 1889, inclusive, our imports of raw cotton ranged from 4,000,000 to 8,000,000 pounds, with a valuation running from 13.5 to 20 cents per pound."

The preliminary returns for 1891 show a very large increase in this importation, which it is estimated will reach 20,908,817 pounds, valued at $2,825,004 at 13.5 cents per pound.

Much the larger proportion of the imports are made up of Egyptian cotton. Peruvian cotton, either from Peru or Brazil, is second in importance, and in addition small quantities are received from China, the East Indies, and other miscellaneous sources. * * * The peculiarity of the Egyptian fiber is its smoothness, brilliancy of color, luster, and silky nature of the staple. It is used by itself mostly in the manufacture of fine hosiery (Balbriggan, etc.) and fine fabrics, and also in mixtures for fabrics composed partly of silk and wool, in great variety. The staple is long and fine, but in these qualities does not equal our home-grown sea-island cotton. * * *

The Egyptian fiber, it is claimed, receives and retains in original brilliancy the different dyes more readily than any other grade.

The Peruvian cotton is the product of the so-called cotton tree, growing upon plants or small trees from 8 to 12 feet in height. The peculiarity of its fiber is almost the opposite of the characteristics of the Egyptian. Where the latter approaches silk the Peruvian cotton might be compared with wool; in fact it is sometimes called wool cotton. On account of the fleeciness of its staple it is generally used in mixtures with wool, especially for rough fabrics and for certain classes of hosiery and knit goods.

It would seem that this country, with its unrivaled conditions for the production of cotton, might be able to produce every quality of fiber demanded by our manufacturers for use in any class of goods. There are, of course, peculiar climatic conditions surrounding tho cultivation of cotton in Egypt and in South America, but it would seem that with our extent of territory, approaching as near a tropical climate as we do, some area might be found for the production of either or both.

The canning industry.—The number of cases of canned corn and tomatoes packed in the United States in 1891 is estimated as follows: Corn 2,799,453, tomatoes 3,405,365. The value of the canned goods exported in 1891 is estimated as follows: Salmon $2,096,957, other fish $139,392, beef $9,068,906, fruits $703,880, vegetables $286,321, total, $12,295,456.

DIVISION OF ENTOMOLOGY.

INSECT LIFE, VOL. IV, NOS. 5 AND 6, DECEMBER, 1891 (pp. 163–230, figs. 14).—The principal articles in this double number are those briefly summarized below:

Mr. Koebele's second trip to Australia (pp. 163, 164).—With the aid of funds appropriated by the California State legislature, Mr. Koebele has been sent to Australia and New Zealand to search for beneficial insects. Four species of ladybirds have been sent to California from Honolulu for use against the black scale (*Lecanium oleæ*). Specimens of *Scymnus acceptus*, *S. consor*, *S. villosus*, *S. flavihirtus*, and *S. fagus* were collected in New Zealand and sent to California, though it is doubtful whether they will accomplish any better results than the species of this genus already there. From Sidney were sent *Orcus chalybeus*, *O. australasiæ*, and a number of Scymnids—enemies of the red scale; another species found feeding on the flat scale (*Lecanium hesperidum*) and the black scale; and *Leis conformis*, enemy of the woolly root louse of the apple. A number of these insects were received alive at Los Angeles; and an attempt will be made to propagate them in California.

Wheat and grass sawflies, C. V. Riley and C. L. Marlatt (pp. 168–179).—Reference is made to previous notes on sawflies in Bulletin No. 4 of this Division and in the Annual Report of the Entomologist for 1884, and on the European corn sawfly (*Cephus pygmæus*) in Bulletin No. 11 of the New York Cornell Station (see Experiment Station Record, vol. I, p. 277), and in Insect Life, vol. II, p. 286. Accounts are given of observations on five forms of larvæ of *Dolerus* spp. found on *Gramineæ* in this country. The adults of but two species, *D. arvensis* and *D. collaris*, have been bred. A female fly of the former species is illustrated. The eggs, larvæ, and adults of *Nematus* (*Messa?*) *marylandicus* are described and illustrated, and a brief account is given of the habits of this insect.

The larva and adult of *Cephus occidentalis*, a new species found on grass in California, Nevada, and Montana, are also described and illustrated. Mention is made of a number of parasites observed to attack the saw-flies studied. Plowing and rotation of crops are recommended as a remedy in case these insects become troublesome.

Importation of a Hessian fly parasite from Europe, S. A. Forbes (pp. 179-181).—An account of the breeding of a generation of *Semiotellus nigripes* in 1891 from imported Hessian fly puparia on infested wheat at Champaign, Illinois, and the successful distribution of the bred insects in fields infested by the fly at the station and in southern Illinois.

Origin and development of parasitism among the Sarcoptidæ, H. Garman (pp. 182–187).—A paper read before the American Association for the Advancement of Science, at Washington, D. C., August, 1891. The author holds that "mites are degraded *Arachnidæ;* that *Sarcoptidæ* are degraded mites, and are not the lowest in rank of the order; that their parasitic habit has been recently assumed; and that their immediate ancestors were free-living mites."

Origin and development of the parasitic habit in Mallophaga and Pediculidæ, H. Osborn (pp. 187–191).—A paper read before the American Association for the Advancement of Science, at Washington, D. C., August, 1891. Peculiarities in the structure of members of these groups are described. For the *Mallophaga* the conclusion is reached that "with the exception of wings, the loss of which has been stated as occurring before the assumption of the parasitic habit, we must admit that parasitism has resulted in specialization and progressive evolution, not retrogression or degradation."

The use of grape bags by a paper-making wasp, M. E. Murtfeldt (pp. 192, 193).—A paper read before the American Association for the Advancement of Science, at Washington, D. C., August, 1891. Notes on observations on the rust-red social wasp (*Polistes rubiginosus*) which tore off fibers and layers of paper from grape bags, presumably for use in nest building.

Methods of pupation among the Chalcididæ, L. O. Howard (pp. 193–196).—This includes the following general statements, which are enforced by references to particular instances:

As a rule Chalcidid larvæ which are internal feeders on their hosts transform internally into naked and more or less coarctate pupæ.

With certain *Encyrtinæ*, for one of which Dr. Riley has proposed the excellent descriptive name of the "inflating chalcis fly," particularly of the genus *Copidosoma*, but also of *Bothriothorax, Homalotylus*, and perhaps others, the larvæ inhabiting the host insect in great numbers, when about to pupate, cause a marked inflation in the host larva by the formation of oval cells around the parasite. * * *

Species parasitic upon endophytous larvæ, and therefore feeding externally, transform to pupæ close to the remains of the host in the burrow or leaf mine, usually attached at the anal end by the præpupal excrement. I have observed a curious variation in the case of *Chrysocharis singularis* in the mine of *Lithocolletis hamadryadella* on oak leaves, which I have described in the *American Naturalist* for January, 1881. In this case the Chalcidid pupa is surrounded by small excremental pillars arranged in an ellipse and connecting the roof and floor of the mine. * * *

The internal parasites of externally feeding larvæ also transform to outside pupæ in a few instances, as with the *Eulophine* genera *Cratotechus* and *Sympiezuz*, and probably with other genera of this subfamily. * * *

The Chalcidid larvæ which feed externally on outside feeding larvæ (and we know only one genus—*Euplectrus*—in which this habit prevails) spin a coarse, rough silk, attaching the depleted skin of the host insect to the leaf on which it had been feeding, and transform to pupæ side by side in a regular transverse row in the silky mass. * * *

The larvæ of the closely allied genus *Elachistus* pupate externally, but do not spin the loose silk characteristic of *Euplectrus*.

The hitherto accepted observation that *Coryna clavata* spins a true cocoon is refuted. From cocoons like those described as belonging to *Coryna*, insects of the Aphidid genus *Praon* have been bred.

The figures accompanying the article illustrate a larva of *Lithocolletis* which has been infested by *Copidosoma;* a Coccinellid larva infested by *Homalolytus obscurus;* a leaf mine of *Lithocolletis hamadryadella* with top removed showing pupa of *Chrysocharis singularis* and supporting pillars; pupæ and adult female of *Cratotechus* sp.; pupæ of *Elachistus spilosomatis* attached to shrunken larva of *Spilosoma virginica;* and a cocoon of *Praon*.

Notes on grass insects in Washington, D. C., H. Osborn (pp. 197, 198).—Brief notes on a number of species observed on a lawn in August, 1890. *Cicadula quadrilineata* was especially abundant and accompanied by *C. nigrifrons*, which occurred in considerable numbers.

An interesting aquatic bug (pp. 198–200).—An illustrated description of an undetermined Hydrobatid water bug found by J. L. Zabriskie of Flatbush, Long Island.

Hominivorous habits of the screw worm in St. Louis, M. E. Murtfeldt (pp. 200, 201).—An account of a case in which over two hundred larvæ of the screw worm were taken from the nasal cavities of a woman.

Another spider-egg parasite, L. O. Howard (p. 202).—A description of *Acoloides emertonii*, n. sp., reared by J. H. Emerton from the egg cocoon of an unknown spider.

DIVISION OF BOTANY.

Bulletin No. 12.

Grasses of the Southwest, Part II, G. Vasey (plates 50).—This is the second half of the first volume of the Illustrations of North American Grasses. For an abstract of the first half of this volume see Experiment Station Record, vol. II, p. 259. The second part includes plates and descriptions of fifty additional species of the grasses of the desert region of western Texas, New Mexico, Arizona, and southern California, as follows: *Aristida purpurea, Chloris swartziana, Cottea pappophoroides, Diplachne fascicularis, D. imbricata, D. reverchoni, D. rigida, D. viscida, Elionurus tripsacoides, Elymus sitanion, Eragrostis curtipedicellata, E. lugens, E. oxylepis, E. purshii, Hilaria rigida, Lycurus phleoides, Muhlenbergia buckleyana, M. depauperata, M. neo mexicana, M. schaffneri, Munroa squarrosa, Oryzopsis fimbriata, O. membranacea,*

Paspalum distichum, P. lividum, P. pubiflorum, Phalaris intermedia, var. *angusta, Pappophorum apertum, P. wrightii, Schedonnardus texanus, Scleropogon karwinskianus, Sporobolus argutus, S. buckleyi, S. interruptus, S. tricholepis, S. wrightii, Stipa pennata, S. scribneri, Trichloris pluriflora, T. verticillata, Triodia acuminata, T. albescens, T. eragrostoides, T. grandiflora, T. nealleyi, T. pulchella, T. stricta, T. texana, T. trinerviglumis, Trisetum hallii, T. interruptum.*

WEATHER BUREAU.

Monthly Weather Review, Vol. XIX, No. 10, October, 1891 (pp. 233–258, charts 6).—Besides the data for October on the topics regularly treated in this publication, there is a short article by H. A. Hazen containing some general statements with reference to the fluctuations of temperature and pressure at the base and summit of Mount Washington in New Hampshire, which have been represented in charts in several recent numbers of the Review. The substance of this article is as follows:

The last chart in this Review contains a continuation of the curves previously published, and completes these fluctuations for the months of January, February, and March, from 1871 to 1886, or for 16 years.

(1) An interesting question arises as to the effect of the mountain upon the temperature of the air. The curves seem to show that if there is any effect it is exceedingly slight and can not influence the maximum and minimum points, except to prevent the extreme rise and fall in warm and cold waves that might occur in the free air; In other words, the temperature in a warm wave might not rise quite so high if the summit were cooler than the air and might not fall quite so low in a cold wave if the summit rocks were warmer than the air. It would appear that under any and all circumstances the dips and rises in the fluctuations of temperature at the summit would not be shifted appreciably in time of occurrence by the presence of the mountain.

(2) Is the diurnal range entirely eliminated from the base curve? It will be noted that the base curve shows a great many minor fluctuations of temperature not to be found in the summit curve, and a close inspection will show that many of these are due to the diurnal range. For example, with a clouded sky the diurnal range has been overcompensated, since the clouds prevent radiation at night and isolation by day. These cases, however, are very few and the effects are not sufficiently strong to obliterate the larger fluctuations.

(3) As was to be expected, the fluctuations of pressure are almost exactly identical at the base and summit. Occasionally the change in temperature at the summit has preceded that in pressure to such an extent as to cause the pressure phases to lag behind at the summit.

(4) As has been noted before, the most marked characteristic in the temperature curves has been their closeness at base and summit, indicating apparently a general effect, not essentially modified by local causes. The earlier change at the summit in both cold waves and hot waves is remarkable and does not seem to be due, as has been suggested, to the greater rapidity of the upper current which carries the warm or cold air from the west more rapidly to the summit than to the base. It will be seen that any effect of this kind would be very quickly obliterated by the motion of the air. Again, while on some accounts warm air from the earth's surface might produce such an effect, it would seem that cold air could not have this source, but must come from above.

Observations are much needed at very much greater heights, even up to 30,000 feet, in order to settle these and many other questions.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

The formation and oxidation of nitrites during nitrification, S. Winogradsky (*Compt. rend.. 113 (1891), pp. 89–92; abs. in Jour. Chem. Soc., 1891, p. 1545*).—In continuation of investigations on nitrification (see Experiment Station Record, vol. II, p. 751) the author made use of soils from different parts of the world. From these soils cultures were made in solutions containing ammonium sulphate and other mineral salts together with magnesium carbonate. In every case nitrification commenced with the formation of nitrites. But when successive cultures were made the results were not parallel. With all the European soils the formation of nitrites proceeded slowly and with diminishing activity, ceasing altogether after a number of generations. With other soils the rate of oxidation was not only maintained, but could be increased by successive additions of ammonium salts to the solution. This was especially true of certain soils from Africa and South America. The formation of the nitrites was in general much more rapid than their oxidation.

Several different kinds of microbes were observed in the cultures, especially in those in which nitrates had been formed. One predominant form closely resembled the nitrous microbe previously discovered. Several of the forms analogous to the nitromonad were isolated and found to retain their power of oxidizing ammonia, but to soon lose that of oxidizing nitrates. Negative results were obtained in attempts to isolate the nitric organism from Tunis soil by gelatin culture, but the method previously employed by the author in isolating the nitrous microbe was more successfully used. A solution of nitrites was sown with Quito soil, and when the oxidation had become regular a little drop of the culture was sown in gelatinous silica. Colonies of two different organisms appeared, one of which proved to be the nitric microbe. It has the form of a minute, irregular, angular rod, and bears no resemblance to the nitrous organisms found in the same soil. Sown in the solutions of nitrites, it changes them rapidly into nitrates but has no effect on ammonia. Organisms with a similar function were observed in soils from Java and Zurich. These probably belong to a different genus from the nitrous organisms, each species having its habitat in a particular soil.

The formation of nitrates in the process of nitrification, S. Winogradsky (*Ann. de l'Institut Pasteur, 5 (1891), p. 577; abs. in Chem. Ztg., 15 (1891), rep., p. 345*).—The author draws the following conclusions from his more recent studies of the organisms of nitrification. The product of nitrification in normal soils is always nitrates exclusively, a fact long believed to be true. The oxidation of the nitrites to nitrates is not diminished in the least by the presence of even considerable quantities of ammonia, but takes place immediately on their formation. There can be no doubt, he asserts, that in the soil as well as in liquid cultures the pure nitrous ferment produces nitrites exclusively; and that when these nitrites are once formed they can not be further acted upon and oxidized by the nitrous ferment, *i. e.* the nitrite organisms can not produce nitrates. The nitrites thus formed in the soil are constant compounds in the absence of the nitric ferment, whether or not the common soil microbes be present. But if the nitric and the nitrous ferments are both brought into sterilized soil provided with ammonium salts, nitrates result, and only occasional traces of nitrites can be detected. The nitrites formed are oxidized immediately to nitrates, no matter how much ammonia is present which the nitrous ferments have not attacked.

These conclusions agree in the main with and confirm Warington's results and views. Regarding the morphology of the nitrifying organisms there is some difference of opinion. Winogradsky describes the nitric ferment as consisting of long, pear-shaped rods not over 0.5μ long and usually about one half to two thirds as broad; and the nitrous ferment as from four to five times as large as the nitric organism and more nearly elliptical in form.

On the fixation of free nitrogen by plants, T. Schlösing, jr., and E. Laurent (*Compt. rend., 113 (1891), pp. 776–779*).—A report on experiments in continuation of those described in *Comptes rendus*, 111 (1890), p. 750 (see Experiment Station Record, vol. III, p. 116). Both the "direct" and "indirect" methods of determining the acquisition of nitrogen were employed, as in the previous experiments. In these later experiments, however, natural soils were used, which were treated as follows: To a poor, sandy soil was added lime and a mixture of richer soils (garden soil and soil on which grain, clover, lupines, and beans had been grown). A mineral solution was used as a fertilizer. After the seeds of various plants had been sown a liquid mixture of distilled water and the soils above mentioned was poured over the surface of the soil in the pots. Two series of experiments were made. In the first, which extended from May to August, the plants grown were Jerusalem artichoke, oats, peas, and tobacco. There were also pots which contained no plants. After a time the soil in all the pots was more or less covered with green plants of a low order, especially certain species of mosses and algæ. The results showed that in every case gaseous nitrogen had

been acquired by the soil or the plants, the amount varying in a general way with the amount of the green vegetation above referred to.

In the second series, from August to October, to prevent the growth of the green organisms the soil was covered with a layer of calcined quartz sand. Oats, peas, mustard, cress, and spurry were grown, and, as before, pots were left without plants. There was no growth of the mosses and algæ and no appreciable acquisition of nitrogen, save in the case of the peas, which in this series, as in the first, acquired a large amount of nitrogen.

On the fixation of nitrogen by the soil, A. Gautier and R. Drouin (*Compt. rend., 113 (1891), pp. 820–825*).—In partial agreement with the investigations of Schlösing, and Laurent above described, the authors quote from *Comptes rendus*, 106 (1888), pp. 1174, 1233, and 1234, reports of former experiments by themselves in which the important functions performed by algæ in aiding the acquisition of nitrogen by the soil and growing plants are shown. They do not, however, believe that the presence of algæ is essential to this process. With the aid of illustrations drawn from their own investigations and those of Pasteur and Berthelot they attempt an explanation of different processes in the fixation of nitrogen, which may be briefly summed up as follows: By reason of the porosity of the soil, and the presence in the soil of oxidizable organic substances (humus) and of aërobic microbes which continuously cause oxidation, a small quantity of combined nitrogen is fixed in the soil from the surrounding atmosphere. The preparatory absorption of this nitrogen by the microbes is without doubt one of the conditions of its oxidation. These organisms afterward give it out to the soil in the form of organic and amide nitrogen. The algæ, nitrous and nitric ferments, etc., in their turn take part in the fixation of these residues. But they do not appear to be indispensable to the process, as was indicated by the experiments of the authors, especially those in which neither algæ nor nitric ferments were present. In this way are explained the part performed by humus materials, the usefulness of the ventilation and cultivation of the soil, the non-assimilation of nitrogen by soils sterilized by heat or antiseptics (as long since observed by Berthelot), and the influence of algæ growing on the surface of the soil. To establish the fact that the algæ directly fix free nitrogen it would be necessary to cultivate them in inclosed media incapable of fixing combined nitrogen, and to show under these conditions the direct accumulation of nitrogen in the substance of these organisms. The organic material which exists in all arable soils is the indispensable intermediary of the fixation of the free or ammoniacal nitrogen of the atmosphere.

For further discussions of some of the points involved in these investigations, see *Comptes rendus*, 113 (1891), p. 1059, and 114 (1892), p. 19.

Soil inoculation for yellow lupine, Salfeld (*Deut. landw. Presse, 1891, p. 1033*).—The author states that in experiments in soil inoculation it is important that the inoculating soil should contain in abundance the bacteria wanted and that attention should be paid to its mechanical condition, its application at the proper time, and its thorough admixture with the ground soil. He reports experiments with yellow lupine on a light sandy soil, poor in humus, which had long been under cultivation, but never with leguminous plants, so far as known. Kainit and Thomas slag were used on all the plats, and half received lupine soil at the rate of about 3,500 pounds per acre. The uninoculated as well as the inoculated plats produced good crops of lupine, but the plants developed better and had a much darker color on the inoculated plats.

Another series of experiments on a sandy soil previously uncultivated gave more marked results. The land was in the midst of an uncultivated heath remote from cultivated land, and the soil was very poor, being almost devoid of clay and humus. A piece containing about 0.4 of an acre was spaded in the fall of 1890, and in November 800 pounds of kainit and 200 pounds of Thomas slag (with 20 per cent phosphoric acid) per acre were applied. The following May 900 pounds per acre of sand from a field where lupine had been grown was applied to a strip (about a third) running through the center of the field; then the whole field was harrowed and seeded to yellow lupine.

About a week after the first leaves appeared tubercles were found in large numbers on the roots where the soil had been inoculated, but elsewhere the roots were mostly free from tubercles. A week later differences between the inoculated and uninoculated plats were apparent in the plants themselves, both in growth and color. While the plants on the inoculated plat grew luxuriantly, were of a dark green color, and sent out numerous branches, those on the uninoculated plats generally formed no chlorophyll, made a stunted growth with no branches, and hardly produced flowers.

The whole field was cut September 14, when the inoculated plants were in bloom. The yield of green material from the untreated soil was many times that from the inoculated soil.

Conditions most favorable to the beneficial action of fluorides on yeast fermentation, J. Effront (*Bull. Soc. Chim., 3 ser., 6 (1891), pp. 786–793*).—As the author previously showed, hydrofluoric acid and fluorides, besides exerting an antiseptic action upon yeast, act at the same time directly upon the protoplasm of the cells. Further experiments have shown that the favorable action of fluorides is dependent on certain conditions. The antiseptic action depends largely on the acidity of the wort, being only very slight in a neutral wort and increasing with the degree of acidity. The acidity likewise controls in a measure the action of fluorides on the protoplasm. One of the most important

factors in determining this latter action is the presence or absence of phosphates. A saccharine solution free from phosphates ferments much better without than with fluorides; while in a solution containing phosphates the reverse is true. The apparent action of the phosphates and fluorides was weaker in proportion as the amount of yeast in the wort increased.

Sodium as a plant nutrient, A. Atterberg (*Deut. landw. Presse, 1881, p. 1035*).—Although it was long ago shown by means of water cultures that plants can make a perfectly normal development without sodium being furnished, the fact remains that sodium is a very common constituent of the ash of plants, and this led the author to test the question whether this element might not be capable of replacing in part other similar plant constituents, and especially potash. Two series of experiments were made the past year with black Tartarian oats, which were grown in pots filled with quartz sand and watered with nutritive solutions containing acid potassium phosphate, magnesium sulphate, and potassium, sodium, and calcium nitrates. Different amounts of the potassium were replaced by like amounts of sodium in the first series and of calcium in the second series. The second series received no sodium salts. It was expected that with the diminished supply of potash salts the yield would fall off, but should the plants be able to use the sodium in place of part of the potash the decrease in yield would not be as large as in the calcium series. All of the trials were made in duplicate. The average yields were as follows:

Potassium supplied per culture.	Yield of oats.	
	Sodium series.	Calcium series.
Grams.	*Grams.*	*Grams.*
9.42	141	142
8.47	144	142
7.53	139	135
6.59	140	135
5.65	134	112
4.71	132	111
3.77	132	108
2.82	120	92
1.88	112	75

These results, the author believes, clearly show that sodium may fill a very important function in case of a deficiency in potassium, and that it is therefore not to be regarded as an altogether useless plant constituent. These experiments he states show that the practice of applying salt to the soil is a rational one from a scientific standpoint, and that the large amount of sodium salts contained in many of the Stassfurt salts is not to be regarded as useless ballast, but as possessing certain values for the nutrition of plants.

Through private correspondence he learns that Professor Wagner of Darmstadt has obtained results similar to the above.

Studies on the ripening of cherries, on the products of fermentation of cherry and currant juices, and on the coloring matter of black and of red currants, W. Keim (*Zeitsch. f. analyt. Chem., 13, pp. 401–427*).—In his studies of the changes during the growth and ripening of the fruit of the cherry (*Prunus cerasus*—early egriot), the author paid especial attention to the nature of the acids and the sugars present, since he proposed to study the products of fermentation of the juice. Between May 15 and June 19 samples of the fruit were gathered at intervals of from 1 to 2 weeks, and submitted to chemical and microscopical tests. The results of these follow:

Cherries at different stages of ripening.

Date.	Condition of fruit.	Average weight of ten cherries.	Water.	Total acid calculated to malic.	Invert sugar.	Cane sugar.	Ash.	Acids present.	Glucoses present.
		Grams.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		
May 15	Green; size of a pea.	6.375	88.88	0.213	2.74	0.187	0.478	Malic, citric, and succinic.	Not determined.
May 21	Green; slightly larger.	8.259	83.73	0.310	3.13	....	0.516	....Do	Dextrose, levulose, and inosite.
May 28	Turning red ..	13.210	82.13	0.412	4.14	0.28	0.646	....Do	Do.
June 10	Nearly ripe...	30.80	83.63	0.421	9.12	1.17	0.656	Malic and citric.	Not determined.
June 19	Fully ripe	37.19	81.22	0.462	10.26	....	0.739	....Do	Dextrose, levulose, and traces of inosite.

The cane sugar in the leaves was determined on the four last dates, the percentages found being 0.436, 0.465, 1.321, and 0.831 respectively.

With the commencement of the development of the fruit the dry matter increased steadily from 11.12 to 17.87 per cent. At the time the latter content was reached an increase in the size of the fruit took place, the average weight of ten cherries increasing from 13.2 to 30.8 grams. With this increase in weight the percentage of sugar in the fruit doubled and increased in the leaves, and the starch disappeared from the fruit and increased in the fruit stalk. The increased weight of the fruit is believed to have been due to an additional storage of water and accelerated sugar production during this period. The percentage of acids increased throughout the ripening, which is contrary to the old view that the sugar is formed at the expense of the acids. The sugar in the leaves increased with the increase of sugar in the fruit, and diminished when the fruit became ripe, which is in accord with observations by Neubauer and Hilger on the grape. No other sugar but cane sugar was detected in the leaves (the probable seat of its formation) and since no acid was present in the leaves, thus excluding the possibility of an inversion, the author is led to assume that cane sugar is the first stage in the production of the sugar, the glucose in the fruit resulting from an inversion by means of the acids there.

Besides malic, citric, and succinic acids, crystals of calcium oxalate were found in considerable quantity with the microscope, and traces of formic and acetic acids were noticed. Although the percentage of acids increased as the cherries ripened, the fruit became sweeter to the taste, owing to the increased production of sugar. The disappearance of succinic acid as ripeness approached suggests the theory that the acids present in the ripened fruit were formed synthetically from succinic and oxalic acids.

Analyses were made of the ash of cherries gathered when the fruit was green, turning red, and fully ripe, with the following results:

Ash of cherries at different stages of ripening.

	May 21.	May 28.	June 19.
Portion soluble in water:	*Per cent.*	*Per cent.*	*Per cent.*
SiO_2	....	1.510	1.8420
HCl	0.712	0.424	1.2340
SO_3	2.934	4.063	3.1800
P_2O_5	2.509	3.438	5.4034
Na_2O	1.217	1.331	1.3420
K_2O	39.459	40.900	44.2090
CO_2	15.125	14.831	15.3060
Portion soluble in HCl:			
Not precipitated by ammonia			
CaO	2.252	3.540	3.1926
MgO	2.143	1.949	1.5441
CO_2	4.124	4.919	4.2071
Portion of the ammonia precipitate soluble in acetic acid:			
CaO	5.578	3.316	2.0003
MgO	2.774	3.446	3.0876
P_2O_5	11.907	11.590	8.0174
Portion of ammonia precipitate insoluble in acetic acid.			
Fe_2O_3	0.918	1.151	1.6521
Al_2O_3	2.552	0.800	0.8126
P_2O_5	4.502	2.018	2.5361
Total	98.707	100.226	99.5663

The results show a steady increase in the water-soluble portion, especially in the potash and the phosphoric acid combined with alkalis, while the amount of calcium in combination with organic acids was highest May 28, and fell off as the fruit ripened. This latter occurrence agrees with the amount of organic acids found. The phosphate of iron increased and the phosphate of calcium and magnesium slightly diminished as the fruit ripened.

Thirteen experiments were made on the fermentation of the juice of cherries and currants, both with and without the addition of yeast, sugar (up to 20 per cent), and water. The resulting wines were bottled and kept in a cellar for 3 months, after which they were analyzed. The acids were found to have diminished most in those samples to which yeast was added, so that the decrease of acids was greater the more lively the fermentation. The decrease of the non-volatile acids during fermentation was relatively greater in the case of cherry juice than of the currant juice. This difference is attributed to the character of the fruit acids present, malic acid predominating in the cherry and citric acid in the currant. Malic acid seemed to decompose more easily under fermentation than citric acid.

The amount of volatile acid seemed to be dependent on the duration of the fermentation. The addition of sugar to the juice slightly increased the glycerin and very considerably increased the alcohol in the product.

The action of nitric and hydrochloric acids, ammonia, limewater, acetate of lead, barium hydrate, amyl alcohol, zinc and hydrochloric acid, and copper sulphate on the juices of red and black currants, was compared with their action on huckleberries, cherries, mallow, and phytolacca berries, and studies were made of the spectra of the juices of these fruits. The results of both chemical and optical tests of the juices of red and black currants corresponded quite closely, from which it appears that the coloring matters of the two fruits if not identical are closely related.

Coöperative feeding experiments with milch cows, fattening oxen, and fattening sheep in Prussia, by the Halle Experiment Station and by farmers.—During several years past a number of series of feeding experiments have been conducted in the Province of Saxony, Prussia, which though intended for the study of questions of local importance are of more than local interest. The results are summarized here because of the light they throw upon the questions of narrow *vs.* wide rations, larger *vs.* smaller quantities of digestible nutrients, and watery *vs.* dry feeding stuffs; and because of the illustrations they give of the advantage of coöperation between the station and the farmer and of a way in which such coöperation may be successfully carried out in feeding experiments.

The experiment station of the Central Agricultural Society of the Province of Saxony is located at Halle in a region where farming is conducted upon a highly intensive system. The policy of the station has been to ally itself closely with the farmers and to institute experiments among them for the study of practical questions regarding the use of fertilizers, culture of sugar beets, feeding of animals, and the like.

In this part of Germany the sugar beet industry is very prominent, and the diffusion residue from which the sugar has been extracted is a very important feeding stuff. The manufacture of alcohol from potatoes is conducted upon a large scale on many farms, and the potato residue is likewise an important factor in feeding. Large quantities of concentrated feeding stuffs, such as oil cake, barley meal, and the like, are also fed with the hay, straw, and other coarse fodders.

It is a question among the farmers of this region whether more liberal rations than the current feeding standards, such as Wolff's, provide for, may not be profitable. It is also desirable to know how much of such watery food as the beet and potato residues may be fed to advantage. And finally the question of the proportion of nitrogenous and non-nitrogenous material in the concentrated foods, in other words, the old question of wide *vs.* narrow rations, is felt to demand more thorough testing than it has received.

In accordance with a suggestion by the director of the station, Professor Maercker, an arrangement was made between the station and the *Halberstädter landwirthschaftlicher Verein*, one of the branches of the provincial agricultural society, by which these questions should be put to the test of coöperative experiment. It was provided that the plans should be drawn up by a commission, consisting of members of the *Verein* and the director of the station; that the tests should be carried out by a number of farmers who were in condition to make them accurately with a considerable number of animals; and that analyses of the feeding stuffs and the milk should be made by the station, which should also work out and publish the results. Dr. Morgen, one of the assistants of the station, was placed in the immediate charge of its share of the coöperative enterprise.

A brief account of the results of the trials of the first season was published shortly after their completion. Although they have excited much attention in the Province, and are regarded by experts in Germany as of more than usual interest, they have received but little attention in the United States, a fact which is not surprising, since the full details are not yet in print.*

The questions proposed for investigation in the experiments of the first season (1887–88) are stated and explained by Maercker and Morgen in their report, as follows:

(1) "How large quantities of the very watery feeding stuffs which are so important in our Province, namely, diffusion residue of beets and potato residue, can be fed without impairing the profitableness of the production of milk by cows or of flesh by fattening animals?"

The views of practical feeders in the Province regarding this question are extremely various. Some hesitate to feed more than 66 pounds of beet residue to grown cattle per head per day, while others do not fear to give 110 pounds or more. With potato residue the range is still wider—from 15 to 25 gallons per head per day.

(2) "Starting with a ration of attested quality and quantity, how much concentrated fodder can be added without impairing the profit of production, and what is the best nutritive ratio?"

Here again the widest differences of opinion are found among practical men. Taking the same basal ratio of diffusion residue, potato residue, and hay, some consider an addition of 5.5 pounds of concentrated food per head per day as large as can be used to advantage, while others regard 11 pounds or more as the most profitable.

With regard to these questions it was clearly understood at the outset that categorical answers applicable in all places would be impossible, so wide are the differences in individuality and productive capacity of different herds. But as the farms on which the experiments were

*A preliminary report by Professor Maercker and Dr. Morgen was published in the Magdeburgische Zeitung, November 21 to December 6, 1888. Abstracts of this are given in Centralbl. f. Agr. Chem., 1889, p. 460, and Jahresber. ü agr. Chem., 1889, p. 611.

made were sugar beet farms, either with or without distilleries, and the methods of management were essentially similar and the herds not very different from one another, there was nothing in the way of experiments on a common plan. At the same time the authors are particular to warn against too general application of the results, the more so as they have largely to do with pecuniary profits.

The concentrated feeding stuffs used in these experiments, namely, cotton-seed, palm nut, peanut and barley meals, and the hay and straw of the coarse fodder, were analyzed in advance. The beet and potato residues had to be analyzed from time to time during the progress of the experiments. The digestibility of each feeding stuff was computed by use of Wolff's coefficients (as given in *Mentzel und v. Lengerke's landw. Kalender*), except that for the protein in a considerable number of cases determinations of digestibility were made by Stutzer's method.* Using the proportions of digestible nutrients as computed from the figures for composition and digestibility, the quantities of the several feeding stuffs in each ration were calculated and fed to the animals. In thus making up the rations some difficulty was experienced from the fact that the straw was fed *ad libitum* and the quantities which the animals consumed were variable, hence changes were required in the quantities of the other materials so as to make the rations as a whole uniform. There was, however, only one instance in which it was not practicable to make the rations satisfactory (series B, p. 562.)

One valuable feature of the experiments as tests of the economy of the different rations was the method of estimating the financial results. The accounts were kept on each farm by a system proposed by a specialist in agricultural bookkeeping, Professor Howard of the Agricultural Institute of the University of Leipsic, and carried out under his direction on a considerable number of farms. In the reports of the experiments estimates are made of the pecuniary gain or loss with each ration. For this purpose valuations appropriate to the locality were made of the feeding stuffs consumed, the milk, the increase of live weight of fattening animals, and the manure produced. The valuations of manure were based upon the quantities of nitrogen and phosphoric acid as estimated from the composition of the feeding stuffs. No account was taken of the potash or other ingredients. In making these estimates it was assumed that all of the nitrogen and phosphoric acid of the fodder which was not stored in the bodies of the animals or converted into milk would be saved in the manure. The estimates of cost of care and keeping of the animals included interest on capital

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* The accuracy of the estimates of digestible protein in these experiments has been called in question by Pfeiffer, Centralbl. f. agr. Chem., 1890, p. 424, but explanations by Professor Maercker (*ibid.*, p. 553), with details not given in the report, show that they were made as correctly as the circumstances would allow, and are to be relied upon.

invested, rent of buildings, etc. In the calculations of financial results the following valuations were used:

Feeding stuffs per 100 pounds.

	Cents.
Hay (including clover hay)	65
Straw and chaff (of cereals)	22
Pea straw	28
Lupines	100
Maize meal	130
Barley meal	114
Wheat bran	87
Cotton-seed meal	137
Peanut meal	135
Palm nut meal	114
Poppy cake	95
Diffusion residue of beets	6.5
Potato residue	8.1

Live weight of animals per pound.

	Cents.
Oxen, before fattening	5.6
Oxen, after fattening	6.2
Sheep	5.6
Milch cows	5.6

Milk per pound, 1.08 cents.

Valuable ingredients of fertilizers per pound (potash not reckoned).

	Cents.
Nitrogen	13.0
Phosphoric acid	4.3

Expense of care and keeping of animals (exclusive of food).

	Cents.
Milch cows per head per day	6.0
Fattening cattle per head per day	4.0
Fattening sheep per ten head per day	3.8

The farmers to whom the details of the experiments were intrusted carried them out with fidelity and accuracy that are commended in the highest terms.

The statements of methods and results which follow are taken mostly from the published report, but use has also been made of unpublished data kindly supplied by Messrs. Maercker and Morgen. In the tables that have been constructed from the data thus made available, computations not included in the original have been added, namely, those of the potential energy (fuel value) of the digestible nutrients—1 gram of digestible protein or carbohydrates being assumed to yield 4.1 and 1 gram of digestible fats 9.3 Calories. (The method of making these estimates is explained in Experiment Station Record, vol. I, p. 268. As there

explained, both the method and the figures assumed for energy in the different nutrients are to be regarded as tentative. The object is simply to afford a means of comparing the quantities of actual nutrients in the rations).

Thirteen series of experiments were made and are here summarized. Of these series seven, A–G, were with milch cows; three, H, I, and K, with fattening steers; and three, L, M, and N, with fattening sheep.

EXPERIMENTS WITH MILCH COWS.

In each of these experiments three different rations were used. They differed in the relative amounts of beet or potato residue and dry food in the tests with watery foods, and in the relative amounts of oil meal or barley meal in the tests with concentrated foods. In order to make up for the natural changes in the milk during the period of lactation, each series was divided into five periods. In periods I and V, the first and last, the smallest ration; in periods II and IV the medium; and in period III the largest was fed; that is to say, the rations increased from the first to the middle and then decreased to the last.

For the analyses of the milk samples were taken from each milking of each cow. The amount of each sample was proportioned to the amount of milk yielded. Twice each week all the samples of the milk of each cow were put together and an analysis of this united sample was made at the station in Halle. When allowance is made for the natural change in the composition of the milk, as was done by averaging the milk of periods I and V and that of II and IV, no influence of the food on the composition of the milk could be traced, the only variation being in the total amount of milk yields. As this was true in all the experiments, no reference will be made to the composition of the milk in the statements which follow.

Experiments with watery foods.—Of these there were two series, which may be designated A and B. The periods were 10 days each. The basal ration in each case consisted of hay, straw, barley meal, and oil meal. To the basal ration watery foods were added in different proportions in different periods.

Series A, beet diffusion residue added in different quantities to basal ration.—Conducted by Herr Henneberg in Wasserleben. Nine cows, averaging 1,023 pounds live weight. Basal ration per head per day in pounds, lucern hay 5.5, straw from 8.36 in period III to 12.54 in periods I and V, and peanut meal and barley meal in quantities sufficient to give the whole ration the desired composition when fed with diffusion residue in quantities as stated.

Rations; yield of milk; gain or loss in live weight; financial results.

	Periods.		
	I and V.	II and IV.	III.
Beet residue per head per day ....pounds..	44	66	88
Water in total food per head per day ....do....	43.36	62.70	81.66
Digestible nutrients in total food:			
Per head per day—			
Protein ....do....	3.39	3.39	3.39
Fats ....do....	0.52	0.48	0.42
Carbohydrates ....do....	13.49	13.60	13.16
Per 1,000 pounds live weight per day—			
Protein ....do....	3.31	3.31	3.31
Fats ....do....	0.52	0.47	0.41
Carbohydrates ....do....	13.18	13.29	12.86
Nutritive ratios	1:4.4	1:4.4	1:4.2
Potential energy in digestible nutrients per 1,000 pounds live weight per day ....Calories..	36,510	36,420	35,270
Milk yield per head per day ....pounds..	29.39	30.71	31.13
Gain (+) or loss (−) in live weight per head per day ....do....	+1.29	+0.21	−0.013
Financial gain per head per day ....cents..	9.2	10.1	12.6

Series B, beet diffusion residue and potato residue added to basal ration.—Conducted by Herr Oesterreich in Siegersleben. Eight cows, averaging 1,100 pounds live weight, were employed in the experiments, which differed from those of series A in that beet diffusion residue and potato residue were used together, the former in decreasing and the latter in increasing quantities in the different experiments. The basal ration contained, approximately, per head per day, in pounds, hay 5.5, straw 8.4, palm nut meal 2.2, and cotton-seed meal and barley meal in quantities such as to make the amounts of digestible nutrients in the whole ration the same in the different periods. In the third period, however, there was an error in the make-up of the ration by which the quantities of protein and fat were made too small.

Rations; yield of milk; gain in live weight; financial results.

	Periods.		
	I and V.	II and IV.	III.
Beet diffusion residue per head per day ....pounds..	44	33	22
Potato residue per head per day ....quarts..	11	42	63
Water in total food per head per day ....pounds..	81.33	116.53	149.67
Digestible nutrients in total food:			
Per head per day			
Protein ....pounds..	3.37	3.48	2.97
Fats ....do....	0.70	0.68	0.51
Carbohydrates ....do....	12.47	12.91	13
Per 1,000 pounds live weight per day—			
Protein ....do....	3.06	3.16	2.70
Fats ....do....	0.64	0.62	0.46
Carbohydrates ....do....	11.34	11.74	11.82
Nutritive ratios	1:4.2	1:4.2	1:4.8
Potential energy in digestible nutrients per 1,000 pounds live weight per day ....Calories..	32,800	33,740	32,140
Milk yield per head per day ....pounds..	31.22	31.88	27.79
Gain in live weight per head per day ....do....	1.29	0.69	0.96
Financial gain per head per day ....cents..	10.1	8.7	3.6

These experiments, then, represent the average results of trials, in one case with nine and in the other with eight cows. The normal change which takes place in the milk with progress of the period of lactation

is neutralized so far as that is practicable by averaging the results of trials with the same ration in periods near the beginning and the end and equidistant from the middle period. The amounts of watery foods in the rations per head per day were such as to give quantities of water ranging in one series from 43 to 82 pounds, and in the other from 84 to 150 pounds. As the watery food was increased the dry food was diminished so as to make the quantities of digestible nutrients practically constant throughout each series. The total quantity of nutrients was liberal. The digestible protein per 1,000 pounds live weight per day was somewhat over 3 pounds in both series, while Wolff's standard calls for only 2.5 pounds. The Calories were about 36,000 in the first and about 33,000 in the second, Wolff's standard calling for 29,700. The condition of the cows in respect to fatness at the beginning of the experiment is not mentioned in the report, but where such liberal feeding is practiced, they could hardly be expected to have been very lean, and the fact that with the liberal feeding during the experiments they fell off in live weight when the milk yield increased would favor the supposition that they were not too fat. The results may be briefly summarized thus:

(1) The increase of watery food was without discernible effect upon the composition of the milk.

(2) The quantity of milk increased regularly with the increase of beet diffusion residue (series A), the yield being largest with the largest amount of residue (28 pounds per head per day) with 82 pounds of water in the ration. With the mixture of beet diffusion residue and potato residue (series B) the milk yield likewise increased with the first increase of watery food, which raised the water in the ration from 84 to 116 pounds. With the next increase, which brought the water in the ration up to 150 pounds, the milk yield fell off. But in this case the ration was unintentionally changed so as to reduce the protein from 3.2 to 2.7 pounds per 1,000 pounds live weight and the energy from 33,740 to 32,140 Calories, hence the decrease of milk could not be fairly ascribed to the water in the food. The authors suggest that the very large amounts of water may have increased the nitrogen metabolism and thus tend to decrease the yield of milk or the laying on of flesh.

(3) There was an almost continual gain in live weight throughout all the series of experiments. This gain was in general less as the water in the food was greater. The only exception was in the case in which the largest amount of water of all was fed—period III of series B. This was also the case where the milk yield fell off. That there should be less gain in live weight where the milk yield was larger, is not strange.

Experiments with different quantities of concentrated foods and different nutritive ratios.—Of these there were two sets, (1) with large proportions of protein, and (2) with excess of carbohydrates in the ration. The general plan consisted in taking a ration of attested fitness for milk production as a basis and adding oil meal and barley meal. For

the narrower ration relatively large amounts of the oil meal, and for the wider ration relatively large amounts of barley meal were used.

(1) *Effects of one-sided increase of nitrogenous food.*—To test the effects of large rations with narrow nutritive ratios, two series of experiments, series C and D, were made. In each series the different rations were made up by taking one basal ration for all and adding oil meal and barley meal in different relative proportions.

Series C.—Conducted by Herr Zimmermann in Benkendorf. Six cows averaging 1,375 pounds live weight. Basal ration per head per day in pounds, potato residue 112.2, beet diffusion residue 33, clover hay 5.5, wheat chaff 8.8, wheat bran 1.65, palm nut meal 1.65; cotton-seed meal and barley meal added to this in quantities as stated.

Rations; yield of milk: gain or loss in live weight; financial results.

	Periods.		
	I and V.	II and IV.	III.
Quantities per head per day added to basal ration:			
Cotton-seed meal .... pounds..	1.78	3.23	4.69
Barley meal .... do....	4.40	3.39	2.38
Digestible nutrients in total food:			
Per head per day—			
Protein .... do....	3.17	3.76	4.42
Fats .... do....	0.62	0.77	0.97
Carbohydrates .... do....	6.34	6.19	6.06
Per 1,000 pounds live weight per day—			
Protein .... do....	2.30	2.74	3.22
Fats .... do....	0.45	0.56	0.71
Carbohydrates .... do....	10.14	9.90	9.70
Nutritive ratios	1:4.9	1:4.2	1:3.6
Potential energy in digestible nutrients, per 1,000 pounds live weight per day .... Calories..	27,815	28,800	30,075
Milk yield per head per day .... pounds..	52.12	52.03	52.58
Gain (+) or loss (—) in live weight per head per day .... do....	+ 0.257	+ 1.192	— 0.275
Financial gain per head per day .... cents..	28.6	28.5	29.5

Series D.—Conducted by Herr Braune in Winningen. Eight cows averaging 1,100 pounds live weight. Basal ration per head per day in pounds, beet diffusion residue 66, clover hay 5.5, chaff and straw 15.4, palm nut meal 2.2; peanut meal and barley meal added to this in quantities as stated.

Rations; yield of milk; gain in live weight; financial results.

	Periods.		
	I and V.	II and IV.	III.
Quantities per head per day added to basal ration:			
Peanut meal .... pounds.	1.94	3.70	5.17
Barley meal .... do....	4.66	2.82	2.57
Digestible nutrients in total food:			
Per head per day—			
Protein .... do....	3.26	3.76	4.47
Fats .... do....	0.51	0.55	0.66
Carbohydrates .... do....	15.03	15.22	15.18
Per 1,000 pounds live weight per day—			
Protein .... do....	2.96	3.42	4.06
Fats .... do....	0.46	0.50	0.60
Carbohydrates .... do....	13.66	13.84	13.80
Nutritive ratios	1:5.0	1:4.4	1:3.8
Potential energy in digestible nutrients per 1,000 pounds live weight per day .... Calories..	36,450	37,970	39,690
Milk yield per head per day .... pounds..	25.04	25.41	27.30
Gain in live weight per head per day .... do....	1.44	0.41	0.48
Financial gain per head per day .... cents..	5.4	6.6	8.3

The quantities of food in all the experiments of both series were liberal, as appears from the figures for potential energy. In series C the estimated energy of the digestible nutrients per 1,000 pounds live weight per day ranged from 27,815 to 30,075 Calories. In series D the range was from 36,450 to 39,690 Calories. These numbers exceed the 29,700 Calories which Wolff's standard calls for by from 22.7 to 33.6 per cent. The digestible protein is large both in absolute quantity and in relation to the other nutrients. The amounts per 1,000 pounds live weight ranged in series C from 2.3 to 3.22 pounds, and in series D from 2.96 to 4.06 pounds. These quantities are from 8 per cent smaller to 62.4 per cent larger than the 2.5 pounds of Wolff's standard. The nutritive ratios range from 1: 5 to 1: 3.8. The widest is narrower than 1:5.4 of Wolff's standard.

In series C the cows yielded hardly more milk with the largest ration than with the smaller ones. This the authors think was not strange, since the cows were very near the limit of their capacity for milk production with the smallest ration. The change in live weight was inconsiderable. The estimated financial gain was a little the largest with the largest proportion of nitrogen (*i. e.* with the largest amount of oil cake), which increased the value of the manure.

In series D the milk yield increased somewhat with the increase of total nutrients and nitrogen. The increase in live weight was slightly larger with the smallest ration than with either of the others. The financial showing was a little the best with the largest ration, but here, as previously, the estimate is made more favorable by the value of the manure than it would have been if the milk product alone had been taken into account. Indeed the value of the manure was a very large factor of the gain.

(2) *Effect of one-sided increase of non-nitrogenous food.*—To test the effects of large rations with wide nutritive ratios, three series of experiments, E, F, and G, were made. They were made up in the same manner as those on the effects of narrow rations (series C and D) except that in adding oil meal and barley meal to the basal rations the barley meal was increased and the oil meal diminished to make the wider rations.

Series E.—Conducted by Herr Luedecke in Hoetensleben. Eight cows averaging 1,100 pounds live weight. Basal rations per head per day in pounds, potato residue 112.2, beet diffusion residue 33, hay 5.5, straw 8.8, palm nut cake 2.2; peanut meal and barley meal added to this in quantities as stated.

Rations; yield of milk; gain or loss in live weight; financial results.

	Periods.		
	I and V.	II and IV.	III.
Quantities per head per day added to basal ration:			
Peanut meal ....pounds..	2.24	1.96	1.01
Barley meal ....do....	....	1.80	4.40
Digestible nutrients in total food:			
Per head per day—			
Protein ....do....	3.23	3.39	3.41
Fats ....do....	0.35	0.37	0.40
Carbohydrates ....do....	12.01	13.16	14.52
Per 1,000 pounds live weight per day—			
Protein ....do....	2.94	3.08	3.10
Fats ....do....	0.32	0.34	0.36
Carbohydrates ....do....	10.92	11.96	13.20
Nutritive ratios	1:4.0	1:4.2	1:4.5
Potential energy in digestible nutrients per 1,000 pounds live weight per day ....Calories	30,050	32,600	35,260
Milk yield per head per day ....pounds	33.04	32.41	33.42
Gain (+) or loss (—) in live weight per head per day ....do...	+1.16	—0.51	—1.37
Financial gain per head per day ....cents	13.2	12.7	10.8

Series F.—Conducted by Herr Zimmermann in Benkendorf. Six cows averaging 1,375 pounds live weight. Basal ration per head per day in pounds, potato residue 112.2, beet diffusion residue 33, clover hay 5.5, wheat chaff 8.8, wheat bran 1.65, palm nut meal 1.65; cotton-seed meal and barley meal added to this in quantities as stated.

Rations; yield of milk; gain or loss in live weight; financial results.

	Periods.		
	I and V.	II and IV.	III.
Quantities per head per day added to basal ration:			
Cotton-seed meal ....pounds..	1.78	1.54	1.28
Barley meal ....do....	4.40	6.42	8.45
Digestible nutrients in total food:			
Per head per day—			
Protein ....do....	3.19	3.12	3.34
Fats ....do....	0.62	0.62	0.64
Carbohydrates ....do....	13.95	15.51	17.19
Per 1,000 pounds live weight per day—			
Protein ....do....	2.32	2.27	2.43
Fats ....do....	0.45	0.45	0.46
Carbohydrates ....do....	10.14	11.28	12.43
Nutritive ratios	1:4.8	1:5.5	1:5.6
Potential energy in digestible nutrients per 1,000 pounds live weight per day ....Calories..	27,850	30,080	32,865
Milk yield per head per day ....pounds..	42.11	42.53	41.60
Gain (+) or loss (—) in live weight per head per day ....do....	+ 2.57	—0.029	— 0.55
Financial gain per head per day ....cents..	18.3	16.3	16.0

Series G.—Conducted by Herr Preu in Wernigerode. Seven cows averaging 1,100 pounds live weight. Basal ration per head per day in pounds, beet diffusion residue 66, clover hay 5.5, straw 8.8, palm nut meal, 2.2; peanut meal and barley meal added to this in quanties as stated.

Rations; yield of milk; gain or loss in live weight; financial results.

	Periods.		
	I and V.	II and IV.	III.
Quantities per head per day added to basal ration:			
Peanut meal ....pounds..	2.68	1.65	0.84
Barley meal ....do....	2.73	5.98	9.02
Digestible nutrients in total food:			
Per head per day—			
Protein ....do....	2.88	2.88	2.97
Fats ....do....	0.46	0.51	0.57
Carbohydrates ....do....	12.19	13.35	14.94
Per 1,000 pounds live weight per day—			
Protein ....do....	2.62	2.62	2.70
Fats ....do....	0.42	0.46	0.52
Carbohydrates ....do....	11.08	12.14	13.58
Nutritive ratios	1: 4.6	1: 5.1	1: 5.5
Potential energy in digestible nutrients per 1,000 pounds live weight per day ....Calories..	30,260	32,670	36,040
Milk yield per head per day ....pounds..	33.09	34.39	35.46
Gain (+) or loss (—) in live weight per head per day ....do....	— 0.49	+ 0.92	+ 4.16
Financial gain per head per day ....cents..	15.2	13.7	12.9

For more convenient comparison of the experiments upon narrow *vs.* wide rations, the principal statistics are recapitulated in the accompanying table:

Recapitulation of results of experiments with cows on effects of narrow vs. wide rations upon milk production.

Series.	Number of cows.	Feeding periods.	Average live weight at beginning of experiment.	Gain (+) or loss (—) in live weight per head per day.	Milk yield per head per day.	Financial gain per head per day.	Nutritive ingredients and yield of milk per 1,000 pounds live weight per day. Digestible nutrients. Protein.	Non-protein.*a*	Nutritive ratio.	Potential energy in digestible nutrients.	Milk yield.
Narrow rations.			*Pounds.*	*Pounds.*	*Pounds.*	*Cents.*	*Pounds.*	*Pounds.*	*1:*	*Calories.*	*Pounds.*
C..........	6	I and V	1,375	+0.26	52.1	28.6	2.3	11.2	4.9	27,815	41.7
		II and IV		+1.19	52.0	28.5	2.7	11.2	4.2	28,800	41.6
		III		—0.28	52.6	29.5	3.2	11.3	3.6	30,075	42.1
D..........	8	I and V	1,100	+1.44	25.0	5.4	3.0	14.7	5.0	36,450	22.7
		II and IV		+0.41	25.4	6.6	3.4	15.0	4.4	37,970	23.1
		III		+0.48	27.3	8.3	4.1	15.2	3.8	39,690	24.8
Wide rations.											
E..........	8	I and V	1,100	+1.16	33.0	13.2	2.9	11.6	4.0	30,050	30.0
		II and IV		—0.51	32.4	12.7	3.1	12.7	4.2	32,600	29.5
		III		—1.37	33.4	10.8	3.1	14.0	4.5	35,260	30.4
F..........	6	I and V	1,375	+2.57	42.1	18.3	2.3	11.1	4.8	27,850	33.7
		II and IV		—0.03	42.5	16.3	2.3	12.3	5.5	30,080	34.0
		III		—0.55	41.7	16.0	2.4	13.5	5.6	32,865	33.4
G..........	7	I and V	1,100	—0.49	33.1	15.2	2.6	12.0	4.6	30,260	30.9
		II and IV		+0.92	34.4	13.7	2.6	13.2	5.1	32,670	31.3
		III		+4.16	35.5	12.9	2.7	14.8	5.5	36,040	32.3
Wolff's standard for 1,000 pounds live weight..........							2.5	13.4	5.4	29,740	....

a Fats and carbohydrates together, *i. e.* carbohydrates + (fats × 2.25).

Several general features of the experiments are here brought into clear relief. In the first place the quantities are liberal. Wolff's standard calls for 2.5 pounds of protein and 29,740 Calories per 1,000 pounds live weight. Kühn* gives the following quantities of digestible nutrients as appropriate for milch cows per 1,000 pounds live weight:

	Pounds.
Albuminoids, *i. e.* protein free from amides, etc	1.5– 2.4
Fats	0.4– 0.7
Carbohydrates	12.0–14.0

*Julius Kühn, Zweckmässigste Ernährung des Rindviehs, tenth edition, 1891, p. 561.

These quantities agree pretty well with those of Wolff's standard. If we allow that one fifth of the nitrogen of the feeding stuffs is so-called amide nitrogen, the quantities of crude protein corresponding to the 1.5-2.4 pounds of actual protein Kühn calls for would be from 2 to 3 pounds. The mean of these—2.5 pounds—is exactly the quantity in Wolff's standard. Kühn's mean for non-protein (taking one part by weight of fats as equivalent to 2.25 parts of carbohydrates) would be 14.25 pounds—half a pound more than Wolff's. The potential energy of Kühn's mean ration would be about 31,100 Calories. Of course no one takes such a standard as a fixed measure for the amount of food the average cow ought to have per 1,000 pounds live weight. For that matter, a more logical way to compute the ration would be to reckon a certain amount of maintenance food by live weight, and an additional amount for production by the milk yielded or the fat to be laid on if the cow is to go to the butcher when her milk falls below the point of profitable production. But such standards serve for comparisons, and it is clear that as compared with them the quantities in these experiments were very generous. Using the energy as the measure of the total digestible nutrients Wolff's and Kühn's standards call for 30,000 or 31,000 Calories. The quantities here range from 28,000 to 39,000.

In the second place the quantities of protein are large—from 2.3 to 4.1 pounds per 1,000 pounds live weight as compared with the 2.5 pounds which the standards cited call for. As a corollary, the rations are narrow, the range in width being from 1:3.6 to 1:5.6, that of Wolff's standard being 1:5.4.

Taking the series one by one there are peculiarities worthy of special note. In series C the starting ration, periods I and V, was the smallest of all, reckoned per 1,000 pounds live weight. But the cows were large, so that reckoned per head the food was liberal. The yield of milk was very large. Increasing the protein from 2.3 to 3.2 pounds per 1,000 pounds live weight, increasing the energy from 27,800 to 30,000 Calories, and diminishing the width from 1:4.9 to 1:36 did not materially affect the milk yield. This, as Maercker and Morgen say in their report, was not surprising, since the cows were apparently near the maximum of their capacity for milk production at the start. The slight increase in the estimated pecuniary gain was due to the increased value of the manure.

Series D tells a somewhat different story. The quantities of nutrients per 1,000 pounds live weight were larger than in series C, but the cows were smaller and the quantities per head were nearly the same; the milk yield was only a little over half as large. There was more gain in live weight. The pecuniary profit was smaller with the smaller milk yield. The milk increased distinctly with the increase of protein and the consequent increase of total nutrients. The pecuniary gain increased also, although it is explained as before by the value of the nitrogen and phosphoric acid in the manure.

On the whole, both series C and D show a profit from highly nitrogenous rations and liberal feeding.

With the succeeding series, E, F, and G, in which the rations were equally liberal but had less protein, the results are less favorable in respect to milk production, change of live weight, and pecuniary gain or loss, and this is true notwithstanding the narrow rations of these series are much narrower and the wider rations but little wider than Wolff's and Kühn's standards.

In series E and F the rations per head are nearly the same, but as the cows in F were larger the proportions per 1,000 pounds are smaller, though decidedly liberal as compared with the feeding standards. In each of these the starting ration was moderate in total amount and rather narrow, and when the carbohydrates were increased without increasing the protein the milk yield remained very nearly the same, but the live weight fell off. The pecuniary results were decidedly unfavorable to the use of the non-nitrogenous materials.

With series G the case is different. In live weight of cows and quantities of nutrients it corresponds very closely with E. But whereas in E, as in F, there was a gain in live weight with the starting ration and with the succeeding rations, which contained more non-protein, there was little change in milk production and a falling off in live weight in G. The live weight decreased during the feeding of the first ration, and when carbohydrates were added in the second and third the milk yield and live weight were both increased. The pecuniary result in series G agrees with that of E and F in showing a loss with increase of carbohydrates.

A very probable explanation of the difference in outcome of this last series as compared with the others is found by the authors in the bodily condition of the cows, which they think were somewhat low in flesh at the beginning, so that the carbohydrates in proportions such as not to make the whole ration wider than in this case could make themselves felt in increase of both flesh and milk. According to the data of the experiment, the cows lost half a pound per day with the starting ration, which agreed very well with the standards of Wolff and Kühn in total quantity of nutrients, though it was rather narrower, *i. e.* richer in protein. When non-protein was added, so as to make the ration about equivalent to these standards in width and equal to Kühn's most liberal allowance and much larger than Wolff's standard in amount, both the flesh and the milk increased. The explanation given by the authors certainly accords with the statistics of the experiment.

For those who are interested in feeding experiments there is a lesson of decided value in series E, F, and G. These were made to test the same question—the effect of increase of nitrogenous foods. They were all conducted on the same plan. Series E with eight cows and five feeding periods gave very definite results; there was a gain of live weight with the wider rations and loss with the narrower rations,

even though the quantities of food in the latter were larger and the milk was nearly unchanged in amount and composition throughout when allowance was made for the natural changes in composition of milk with advance of the period of lactation. The same experiment was made with six cows in series F, with the difference, however, that the cows were heavier. The result was the same. It was repeated with seven cows in series G. The cows were of the same weight as those of series E. The results were opposite—loss of weight with the wider rations and gain of weight and increase of milk production with the narrower rations. The most plausible explanation of this difference is that the cows were not in as good flesh in the last series as in the two previous ones.

In these experiments with milch cows two points of special interest are brought out:

(1) On the whole, more liberal rations, and especially rations richer in protein than the accepted feeding standards call for, were the most advantageous. Farmers and dairymen in the United States are apt to feed smaller quantities of protein and of total nutrients than such standards provide. The inference is that more liberal feeding and especially more protein will be advantageous.

(2) The results of the different series did not entirely agree with one another; although a considerable number of cows were used in each instance, the inference is that to make such experiments decisive they must be repeated a number of times.

EXPERIMENTS WITH FATTENING OXEN AND STEERS.

Of these, three series were made, two with diffusion residue and one with nitrogenous feeding stuffs (narrow rations), the corresponding series with wide rations not having been carried out. In each series either fifteen or nine animals were divided into three equal lots. During the feeding period, which continued from 73 to 104 days, the three lots of each series received the same basal ration.

Effects of watery foods in different quantities.—The experiments were made in two series, designated H and I. The basal ration in each consisted of hay, straw, wheat bran, cotton-seed meal, and corn meal.

Series H.—Beet diffusion residue added in different quantities to basal ration.—Conducted by Herr Walther-Wiesbeck in Wegeleben. Fifteen oxen averaging 1,584 pounds live weight, divided into three lots of five animals each. Basal ration per head per day in pounds, hay 5.5, straw *ad libitum* (average consumption 5.5), wheat bran 2.2, and cotton-seed meal and corn meal in quantities sufficient to make the desired quantities of nutrient when the beet diffusion residue was added; beet diffusion residue in quantities as stated. Duration of experiment from January 31 to May 10—101 days.

Rations; gain in live weight; financial results.

	Lot 1.	Lot 2.	Lot 3.
Quantities per head per day added to basal ration:			
Beet diffusion residue .... pounds..	66.00	8.8	110.00
Digestible nutrients in total food:			
Per head per day—			
Protein .... do....	3.3	3.3	3.3
Fats .... do....	0.81	0.7	0.59
Carbohydrates .... do....	15.11	15.73	16.23
Per 1,000 pounds live weight per day:			
Protein .... do....	2.08	2.08	2.08
Fats .... do....	0.51	0.44	0.38
Carbohydrates .... do....	9.54	9.93	10.25
Nutritive ratios	1:5.2	1:5.3	1:5.4
Potential energy in digestible nutrients per 1,000 pounds live weight per day .... Calories..	26,505	26,905	27,220
Gain in live weight per head per day .... pounds..	3.32	3.48	2.75
Financial gain per head per day .... cents..	9.6	10.1	7.3

The total quantities of nutrients in these experiments were relatively small. Thus, Wolff's standard for fattening oxen per 1,000 pounds live weight, calls for protein 2.7, fat 0.6, and carbohydrates 14.8 pounds, with a nutritive ratio of 1: 6 and a fuel value of 35,070 Calories. The smallest average increase of live weight and of profit in these experiments was with the largest amount of watery food.

Series I.—Beet diffusion residue and potato residue added in different quantities to basal ration.—Conducted by Herr Wagner in Warmsdorf. Nine oxen averaging 1,760 pounds live weight, divided into three lots of three each. Basal ration per head per day in pounds, hay 5.5, straw 8.8, bran, 2.2, and cotton-seed meal and maize in quantities sufficient to make the desired amounts of total digestible nutrients in the ration when the beet and potato residues were added; beet diffusion residue and potato residue in quantities as stated. Duration of experiment from January 23 to April 4—74 days.

Rations; gain in live weight; financial results.

	Lot 1.	Lot 2.	Lot 3.
Quantities per head per day added to basal ration:			
Potato residue .... liters..	30.00	45.00	60.00
Beet diffusion residue .... pounds..	66.00	49.5	33.00
Digestible nutrients in total food:			
Per head per day—			
Protein .... do....	3.85	3.85	3.85
Fats .... do....	0.77	0.70	0.70
Carbohydrates .... do....	7.61	7.26	7.05
Per 1,000 pounds live weight per day—			
Protein .... do....	2.19	2.19	2.19
Fats .... do....	0.44	0.40	0.40
Carbohydrates .... do....	9.51	9.08	8.81
Nutritive ratios	1:4.9	1:4.6	1:4.5
Potential energy in digestible nutrients per 1,000 pounds live weight per day .... Calories..	26,240	25,138	24,600
Gain in live weight per head per day .... pounds..	2	2.5	1.87
Financial gain per head per day .... cents..	0.9	5.2	2.0

Effects of one-sided increase of nitrogenous foods.—The experiments were made in one series, designated K. The feeding stuffs were similar

to those of series H and I, except that the variable materials added to the basal ration consisted of cotton-seed meal and maize.

Series K.—Cotton-seed meal and maize added in different quantities to basal ration.—Conducted by Herr Braune in Winningen. Fifteen young steers averaging somewhat more than 1,100 pounds live weight. Basal ration per head per day in pounds, hay 5.5, chaff and straw 3.74, wheat bran 2.2, beet diffusion residue 44, potato residue 101.2, cotton-seed meal and maize in quantities as stated. Duration of experiment from January 30 to May 4—96 days.

Rations; gain in live weight; financial results.

	Lot 1.	Lot 2.	Lot 3.
Quantities per head per day added to basal ration:			
Cotton-seed meal ....pounds..	1.6	2.99	4.38
Maize ....do....	4.29	3.41	2.42
Digestible nutrients in total food:			
Per head per day—			
Protein ....do....	3.52	4.07	4.6
Fats ....do....	0.59	0.73	0.86
Carbohydrates ....do....	12.84	12.78	12.47
Per 1,000 pounds live weight per day—			
Protein ....do....	3.20	3.70	4.18
Fats ....do....	0.54	0.66	0.78
Carbohydrates ....do....	11.68	11.62	11.34
Nutritive ratios	1:4.1	1:3.6	1:3.1
Potential energy in digestible nutrients per 1,000 pounds live weight per day ....Calories..	33,290	34,810	35,835
Gain in live weight per head per day ....pounds..	2.64	2.81	2.86
Financial gain per head per day ....cents..	1.0	3.0	4.0

The total quantities of digestible nutrients are about as in Wolff's standard; the quantities of protein are very large and the nutritive ratios extremely narrow. The gain in live weight increases slightly, and the financial gain decidedly with the increase of protein. It is to be remembered, however, that the valuation of manure from the nitrogenous food counts for a large part of the pecuniary gain.

EXPERIMENTS WITH FATTENING SHEEP.

Of these, three series (L, M, and N) were made, one with one-sided increase of nitrogenous and two with one-sided increase of non-nitrogenous foods. The general plan was the same as that of the experiments with steers.

Series L.—Effects of one-sided increase of nitrogenous foods. Cotton-seed meal and wheat bran added in different quantities to basal ration.—Conducted by Herr Braune in Winningen. Thirty sheep, averaging 105.6 pounds live weight, divided into three lots of ten each. Basal ration per ten head per day in pounds, beet diffusion residue 55, pea straw 7.7, wheat chaff 7.26, and yellow lupines 2.75; cotton-seed meal and wheat bran in quantities as stated. Duration of experiment from January 23 to May 5—104 days.

Rations; gain in live weight; financial results.

	Lot 1.	Lot 2.	Lot 3.
Quantities per ten head per day added to basal ration:			
Cotton-seed meal .... pounds..	1.43	3.08	4.62
Wheat bran .... do....	9.68	7.48	6.27
Digestible nutrients in total food:			
Per ten head per day—			
Protein .... do....	3.32	3.81	4.38
Fats .... do....	0.57	0.68	0.84
Carbohydrates .... do....	12.83	11.90	11.70
Per 1,000 pounds live weight per day:			
Protein .... do....	3.15	3.60	4.15
Fats .... do....	0.54	0.65	0.79
Carbohydrates .... do....	12.15	11.27	11.08
Nutritive ratios	1:4.3	1:3.6	1:3.2
Potential energy in digestible nutrients per 1,000 pounds live weight per day .... Calories..	34,125	33,825	35,275
Gain in live weight per ten head per day .... pounds..	1.67	1.94	2.13
Financial loss per ten head per day .... cents..	—6.1	—3.8	—2.7

Series M.—Effects of one-sided increase of non-nitrogenous foods. Cotton-seed meal and maize added in different quantities to basal ration.—Conducted by Herr Henneberg in Wasserleben. Thirty sheep averaging 99 pounds live weight, divided into three lots of ten each. Basal ration per ten head per day in pounds, beet diffusion residue 66, wheat straw 7.7, pea straw 1.1, wheat bran 2.75; cotton-seed meal and maize in quantities as stated. Duration of experiment from January 23 to April 5—73 days.

Rations; gain in weight; financial results.

	Lot 1.	Lot 2.	Lot 3.
Quantities per ten head per day added to basal ration:			
Cotton-seed meal .... pounds..	2.75	2.31	1.87
Maize .... do....	1.10	3.30	5.39
Digestible nutrients in total food:			
Per ten head per day—			
Protein .... do....	3.50	3.50	3.50
Fats .... do....	0.75	0.77	0.77
Carbohydrates .... do....	12.91	14.28	15.62
Per 1,000 pounds live weight per day:			
Protein .... do....	3.53	3.53	3.53
Fats .... do....	0.76	0.78	0.78
Carbohydrates .... do....	13.04	14.42	15.78
Nutritive ratios	1:4.2	1:4.6	1:5.0
Potential energy in digestible nutrients per 1,000 pounds live weight per day .... Calories..	37,855	40,815	43,595
Gain in live weight per ten head per day .... pounds..	2.13	2.02	2.55
Financial loss per ten head per day .... cents..	—3.2	—6.0	—5.2

Series N.—Effects of one-sided increase of non-nitrogenous foods. Poppy cake and wheat bran added in different quantities to basal ration.—Conducted by Herr Wohltmann in Mahndorf. Thirty sheep averaging 92.4 pounds live weight, divided into three lots of ten each. Basal ration per ten head per day in pounds, beet diffusion residue 66, wheat chaff 7.15, pea straw 8.36, lupines 2.75; poppy cake and wheat bran in quantities as stated. Duration of experiment from January 23 to April 23—91 days.

Rations; gain in live weight; financial results.

	Lot 1.	Lot 2.	Lot 3.
Quantities per ten head per day added to basal ration:			
Poppy cake .... pounds..	4.07	2.42	11.66
Wheat bran .... do....	3.96	8.14	....
Digestible nutrients in total food:			
Per ten head per day—			
Protein .... pounds..	3.01	2.97	2.97
Fats .... do....	0.53	0.48	0.42
Carbohydrates .... do....	12.34	13.82	15.20
Per 1,000 pounds live weight per day—			
Protein .... pounds..	3.26	3.21	3.21
Fats .... do....	0.57	0.52	0.45
Carbohydrates .... do....	13.36	14.95	16.45
Nutritive ratios	1:4.6	1:5.1	1:5.5
Potential energy in digestible nutrients per 1,000 pounds live weight per day .... Calories..	36,995	39,925	42,660
Gain in live weight per ten head per day .... pounds..	2.82	3.26	3.17
Financial gain per ten head per day .... cents..	4.0	4.7	0.9

Wolff's standard for fattening sheep calls for digestible nutrients in pounds per 1,000 pounds live weight, protein 3.2, fat 0.6, carbohydrates 14.8, with a nutritive ratio of 1:5, and 36,000 Calories of energy. As compared with such a standard, the ration of lot 1 in each of the three series of experiments was liberal in total quantity of nutrients and large in amount of protein. The largest gains in live weight and best financial returns were in series N, in which the width of the ration was in the neighborhood of 1:5.

The effects of the nitrogenous and non-nitrogenous rations with fattening steers and sheep are recapitulated in the tabular statement herewith. Wolff's standards provide somewhat different quantities for different fattening periods. The figures here used are means.

Recapitulation of results of experiments on effects of narrow and wide rations in the fattening of steers and sheep.

Experiments.		Average live weight at beginning of experiment.	Average increase of live weight per steer or ten sheep per day.	Financial gain (+) or loss (−) per steer or ten sheep per day.	Digestible nutritive ingredients and increase in live weight per 1,000 pounds of steer or sheep per day.				
					Digestible nutrients.		Nutritive ratio.	Potential energy in digestible nutrients	Increase in live weight per day.
Series.	Lot.				Protein.	Non-protein.			
Narrow rations.		*Pounds.*	*Pounds.*	*Cents.*	*Pounds.*	*Pounds.*		*Calories.*	*Pounds.*
K, steers	1	1,100	2.6	+1.0	3.2	12.9	1:4.1	33,290	2.4
	2		2.8	+3.0	3.7	13.1	1:3.6	34,810	2.6
	3		2.9	+4.0	4.2	13.1	1:3.1	35,835	2.6
L, sheep	1	106	1.7	−6.1	3.2	13.4	1:4.3	34,125	1.6
	2	106	1.9	−3.8	3.6	12.7	1:3.6	33,825	1.8
	3	106	2.1	−2.7	4.2	12.9	1:3.3	35,275	1.9
Wide rations.									
M, sheep	1	99	2.1	−3.2	3.5	14.8	1:4.2	37,855	2.1
	2	99	2.0	−6.0	3.5	16.2	1:4.6	40,815	2.0
	3	99	2.6	−5.2	3.5	17.5	1:5.0	43,595	2.6
N, sheep	1	92	2.8	+4.0	3.3	14.6	1:4.6	36,995	3.0
	2	92	3.3	+4.7	3.2	16.1	1:5.1	39,925	3.6
	3	92	3.2	+0.9	3.2	17.5	1:5.5	42,660	3.4
Wolff's standards for 1,000 pounds live weight:									
Fattening oxen					2.7	16.2	1:6.0	35,070	
Fattening sheep					3.2	16.2	1:5.0	36,000	

In the experiments with steers, of which there were fifteen, divided into lots of five each, the rations were all richer in protein than Wolff's standard, but only lot 3 had as much total nutrients as that standard calls for. There was notably more increase in live weight with lots 2 and 3 than with lot 1, and that increase was greater as the protein and the total amounts of nutrients increased. It is to be regretted that the trials with corresponding increase of non-nitrogenous food could not be carried out so as to compare the effects of wider and narrower rations upon the increase in live weight. There is no proof here of any special advantage in using such large proportions of nitrogenous foods.

With sheep there were three experiments, each with thirty animals, divided into three lots of ten animals each.

In series L, with one-sided increase of protein, the smallest ration was rich in protein, but small in amount as compared with Wolff's standard. When nitrogenous foods were added so as to bring the total amount up to that standard, the increase in weight was larger. Pecuniarily there was loss throughout, but it was least with the largest ration.

In series M, with one-sided increase of non-protein, the quantity was large in the smallest ration, with the addition of non-nitrogenous food; there was, nevertheless, an increased gain in live weight, but the feeding was not as profitable financially.

In series N, also with one-sided increase of non-protein, the smallest ration was likewise liberal. With the first addition of non-nitrogenous food there was increased gain in weight, but where still more was added the gain was not larger. In like manner the pecuniary gain was larger with the second and smaller with the third than with the first. On the whole the results seem to favor quantities fully as large or larger and fully as rich or richer in protein than Wolff's standard.

CONCLUSIONS FROM EXPERIMENTS WITH WIDER VS. NARROWER AND LARGER VS. SMALLER RATIONS.

In discussing the experiments the authors lay stress upon the practical rather than the physiological outcome, and urge that the pecuniary results are dependent upon the local conditions where they were made. But, with the statements above given of the costs of feeding stuffs and of care of the animals and the valuations of the products of milk, meat, and manure, it is clear that even the financial outcome is not devoid of general interest.

The final conclusions are set forth essentially as follows:

1. All the highly nitrogenous rations, including those with the very high content of 4.4 pounds of digestible protein per day and per head of cows and oxen and per ten head of sheep, proved profitable, while all the rations with very large amounts of digestible non-protein gave financially unfavorable results.

2. The inferences are, (1) an excess of carbohydrates and fats is always to be avoided in feeding whether it be for milk or fattening. According

to these experiments, it does not seem profitable to feed more than 13.2 pounds of non-protein* per head of neat cattle or ten head of sheep per day. (2) There is no objection to feeding considerably more protein than current usage and feeding standards call for. The advantage rests partly in the increased production and partly in the higher value of the manure.

An account of some more recent experiments on the feeding value of wet *vs.* dry diffusion residue of beets will be given in the next number of the Record.—[W. O. A.]

Testing milk by means of electricity, W. Thörner (*Chem Ztg., 15 (1891), pp. 1673, 1674*).—The author claims to have conceived the idea of arriving at the percentage of water and fat in milk by measuring the resistance which milk presents to a current of electricity, previous to the announcement of Dohrmann's experiments (see Experiment Station Record, vol. III, p. 421), and that the results recorded below were made independently of Dohrmann. In his experiments he used an instrument on which from 0.1 to 10,000 ohms could be quickly and accurately measured.

The experiments were all conducted in a flat-bottomed glass dish, filled to the same depth with milk each time, and all measurements were made at 17° C., with a distance between the electrodes of 5 cm. His first experiments were made with seventeen samples of milk, containing different percentages of butter fat and of different degrees of acidity. The results showed that in fresh market milk of from 9° to 17° of acidity there was no considerable variation in the resistance, the latter being between 180 and 210 ohms; and that the resistance which the milk offered was entirely independent of the percentage of butter fat it contained. Even after a part of the cream had been removed the resistance remained principally the same, in case no change in the acidity had occurred. It would seem, then, that butter fat, a very poor conductor of electricity, when suspended in a good conducting medium (milk serum) had only a slight effect on the conductibility of the medium. The author therefore believes it to be shown that it is not possible to gain an idea of the fat content of the milk by measurement of its electrical resistance.

He then made a series of tests to determine whether by this method the watering of milk could be detected. Since, according to his own observations, waters of different composition present different resistance to an electric current, six different kinds of water were included in the test. Samples of milk received additions of different amounts of each of these waters. When the watered milks were tested they showed that the conductivity of the milk was diminished by an addition of water in proportion to the quantity added and the purity of the water, the purer the water the greater being the resistance. It was further found that

*Estimating by assuming the calorific value of the actual fats as equal to two and a half times the same weight of carbohydrates and multiplying the weight of the former by this factor and adding it to the latter.

increased acidity also increased the resistance of the milk. But in spite of these facts the author believes that the test may furnish valuable indications as to whether a sample is watered. A milk which under conditions similar to those prevailing in this experiment shows a resistance of over 220 ohms, he claims may be safely assumed to have been watered. To what extent this watering has been carried it is impossible to determine by this method, since the electrical resistance of different samples of poor milk varies by about 20 ohms, and that of different waters which might be used for adulteration may vary as widely as 100 ohms.

The method of W. Schmid for estimating fat in milk, **J. Pinette** (*Chem. Ztg.*, *15* (*1891*), *p. 1833*).—Schmid's method as modified by the author, is described by the latter as follows: Ten c. c. of milk are heated in an Erlenmeyer flask with 10 c. c. concentrated crude hydrochloric acid till the curd is dissolved, but not too long, lest traces of the fat be decomposed. The contents of the flask are partially cooled and then poured into a graduated burette, the flask being thoroughly rinsed out with a mixture of equal parts of ether and petroleum ether. The burette is then nearly filled with the mixture of ether and petroleum ether, reversed, and agitated, and the solution containing the fat allowed to rise to the surface, where it is read off. An aliquot part of the fat layer is pipetted off, evaporated to dryness, and the residue weighed. It is advisable to allow the fat layer to thoroughly separate, so that it contains no water when the aliquot is taken. If insufficient time is allowed for a complete separation, it is suggested to filter through a dry, fat-free filter to remove the water.

TITLES OF ARTICLES IN RECENT FOREIGN PUBLICATIONS.

Lupanin, the alkaloid of blue lupine *(Ueber das Lupanin, das Alkaloid der blauen Lupine)*, CARL SIEBERT.—*Arch. der Pharmazie, 229, pp. 531–546; abs. in Chem. Centralbl., 1892, part I, No. 3, pp. 88.*

On a new non-saturated fatty acid of the series $C^nH^{2n-4}O^2$ *(Sur un nouvel acide gras non saturé de la série $C^nH^{2n-4}O^2$)*, A. ARNAND.—*Compt. rend., 114 (1892), pp. 79–81.*

Composition of crystallized egg albumen *(Zusammensetzung des Krystallisierten Eieralbumins)*, F. HOFMEISTER.—*Zeitsch. f. physiol. Chem., 1892, p. 187.*

The analysis of peptones, C. W. HEATON and S. A. VASEY.—*Analyst, Feb., 1892, pp. 28–34.*

A rapid method for estimating the starch content of potatoes *(Evaluation rapide de la richesse en fécule des pommes de terre)*, H. BOIRET.—*Jour. d' Agr. prat., 1892, tom 1, pp. 162–168.*

The determination and examination of fats, a résumé *(Bestimmung und Untersuchung der Fette)*.—*Zeitsch. f. analyt. Chem., 31, Heft 1, pp. 100–115.*

Determination of fat in dairy products *(Dosage de la matière grasse dans les produits du lait)*, LEZÉ and ALLARD.—*Compt. rend., 113 (1891), pp. 654–656.*

Chloride of sodium in plants *(Le chlorure de sodium dans les plantes)*, P. LESAGE.—*Compt. rend., 114 (1892), pp. 143–145.*

The sources of nitrogen of our leguminous crops, J. B. LAWES and J. H. GILBERT.—*Jour. Roy. Agr. Soc. of England, vol. II, ser. 3, part IV, pp., 657–702.*

The nitrifying ferments of the soil, J. M. H. MUNRO.—*Jour. Roy. Agr. Soc. of England, vol. II, ser. 3, part IV, pp. 702–717.*

On the existence of the phenomena of nitrification in media rich in organic substances and having an acid reaction *(Sur l' existence de phénomènes de nitrification, dans des milieux riches en substances organiques et à réaction acide)*, E. CHUARD.—*Compt. rend., 114 (1892), pp. 181–184.*

Influence of the proportions of clay and organic nitrogen in bare soils on the fixation of atmospheric nitrogen, the conservation of nitrogen, and nitrification *(Influences, dans les terres nues, des proportions d' argile et d' azote organique sur la fixation d' azote atmosphèrique, sur la conservation de l' azote, et sur la nitrification)*, P. PICHARD.—*Compt. rend., 114 (1892), pp. 81–84.*

On the spontaneous oxidation of humic acid and humus *(Sur l' oxydation spontanée de l' acide humique et de la terre végétale)*, BERTHELOT and ANDRÉ.—*Compt. rend., 114 (1892), pp. 41–43.*

Ammonia in the atmosphere and rain water of the tropics *(L'ammoniaque dans l'atmosphère et dans les pluies d'une région tropicale)*, V. MARCANO and A. MÜNTZ.—*Compt. rend., 113 (1891), pp. 779–781.*

Ammonia in rain water and in the air *(L' ammoniaque dans les eaux de pluie et dans l' atmosphère)*, A. MÜNTZ.—*Compt. rend., 114 (1892), pp. 184–186.*

Some new observations on the determination of sulphur in humus and on the nature of the compounds which it forms *(Quelques observations nouvelles sur le dosage du soufre dans la terre végétale, et sur la nature des composés qu'il constitue)*, BERTHELOT and ANDRÉ.—*Compt. rend., 114 (1892), pp. 43–46.*

Contribution to the study of the fermentations of farm manure (*Contribution à l' étude des fermentations du fumier de ferme*), T. SCHLÖSING (pere et fils).—*Ann. Agron., 1892, tom 18, pp. 15–18.*

Ammonium phosphate as a fertilizer (*Ammonphosphat als Düngesalz*), J. H. VOGEL.—*Zeitsch. f. angew. Chem., 1891, Heft 19, pp. 568–573.*

The Florida phosphate beds (*Mittheilungen über die Phosphatlager in Florida*), A. KELLER.—*Chem. Ztg., 1892, Jan. 16, p. 65, Jan. 20, p. 18, and Jan. 27, pp. 110–113.*

Composition of Leguminosæ, F. L. NILSON.—*Kongl. svenska landtbruksakademiens handlingar, S. A., pp. x12; abs. in Centralbl. f. agr. Chem., 20, Heft 11, pp. 734–736.*

Contribution to the study of the growth of cereals (*Contribution à l' étude du developpement des céréales*), HEBERT.—*Ann. Agron., 1892, tom 18, pp. 33–47.*

Effect on the yield of potatoes of harvesting the tubers as fast as they become large enough for market (*Der Einfluss der Entknollung der Kartoffelpflanze auf deren Produktionsvermögen*).—*Forsch. auf d. Geb. d. Agr.-Physik, 14, pp. 425–440; abs. in Fühling's landw. Ztg., 1892, Feb. 1, pp. 103–106.*

Influence of boracic acid on germination (*Action de l'acide borique sur la germination*), J. MOREL.—*Compt. rend., 114 (1892), pp. 131–133.*

In opposition to the theory of the formation of fat from albuminoids in the animal body (*Ueber die Entstehung von Fett aus Eiweiss im Körper der Thiere*), EDUARD PFLÜGER.—*Pflüger's Arch. f. d. ges. Physiol., 41 (1891), p. 229; abs. in Chem. Ztg., 1892, Jan. 23, rep. p. 17.*

The comparative feeding values of decorticated and undecorticated cotton cake, J. A. VOELCKER.—*Jour. Roy. Agr. Soc. of England, vol. II, ser. 3, part III, pp. 585–594.*

Bran vs. cheaper mixtures of feeding stuffs of equal nutritive value (*Ueber den Ersatz der Kleie durch billigere Futtermischungen von gleichem Nahrstoffgehalt*), A. MORGEN.—*Zeitsch. des landw. Cent.-Ver. Sachsen, 1891, pp. 301–313; abs. in Centralbl. f. agr. Chem., 20, Heft 11, pp. 729–731.*

Feeding experiments with fish press cake (*Fütterungsversuche mit Fischpresskuchen auf Alnarp in Schweden*), H. WINBERG.—*Tidskrift för landt. mön, 12, pp. 522–528; abs. in Centralbl. f. agr. Chem., 20, Heft 11, pp. 736–740.*

Effect on the live weight and the composition of the bones and teeth of animals of adding different salts to the food, III (*Versuche über den Einfluss, welchen die Beigabe verschiedener Salze zum Futter auf das Körpergewicht und die Zusammensetzung der Knochen und Zähne ausübt*), H. WEISKE.—*Landw. Vers.-Stat., 40, Heft 2, pp. 81–108.*

The effect of feeding precipitated phosphate of lime on the chemical composition of milk ash (*Ueber den Einfluss des verfütterten präcipitierten phosphorsauren Kalkes auf die chemische Zusammensetzung der Milchasche*), E. HESS and SCHAFFER.—*Landw. Jahrb. d. Schweiz, 5, p. 76; abs. in Chem. Ztg., 1892, Jan. 23, rep., p. 15.*

Effect of the feeding of sugar on the character of the fat in milk (*Einfluss von beigefüttertem Zucker auf die Konstitution des Milchfettes*), ADOLF MAYER.—*Milch-Ztg., 1892, Jan. 23, pp. 49, 50.*

Earthworms and the bacilli of tuberculosis (*Les vers de terre et les bacilles de la tuberculose*), LORTET ET DESPEIGNES.—*Compt. rend., 114 (1892), pp. 186, 187.*

EXPERIMENT STATION NOTES.

ARKANSAS STATION.—The following appointments have recently been made to fill vacancies in the station staff: J. T. Stinson, B. S., horticulturist, vice J. F. McKay; C. L. Newman, B. S., assistant agriculturist at Pine Bluff Substation, vice B. M. Baker; George B. Irby, assistant agriculturist at Newport Substation, vice R. L. Bennett, B. S.

KANSAS STATION.—F. C. Burtis, B. S., has been appointed assistant agriculturist vice H. M. Cottrell, M. S. A. S. Hitchcock is in charge of the botanical department of the station, with M. A. Carleton, M. S., as assistant.

MISSOURI UNIVERSITY.—The main building of the university was destroyed by fire January 9. A large amount of apparatus and the entire library were also consumed. The total loss is estimated at about $345,000, of which about $150,000 was covered by insurance. The State legislature has been convened in extra session to provide means for rebuilding.

The College of Agriculture as reorganized at the beginning of the present college year offers four courses of study, 2-year and 4-year courses for undergraduates, a post graduate course of 2 years, and a farmers' lecture course of 3 months. The last includes lectures on agriculture; breeds, breeding, and feeding of animals; agricultural chemistry; economic botany and entomology; practical horticulture; and veterinary science.

NORTH CAROLINA STATION.—The following act for the protection of seed buyers was passed by the State legislature last year:

"The General Assembly of North Carolina do enact:

"Section 1. That any person or persons doing business in this State, who shall sell seed or offer for sale any vegetable or garden seed that are not plainly marked upon each package or bag containing such seed the year in which said seed were grown, shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be fined not less than ten dollars or more than fifty dollars, or imprisoned not more than thirty days for each and every offense: Provided, That the provisions of this act shall not apply to farmers selling seed in open bulk to other farmers or gardeners.

"Section 2. That any person or persons who shall, with intention to deceive, wrongly mark or not label as to date any package or bag containing garden or vegetable seed, shall be guilty of a misdemeanor, and upon conviction thereof shall be fined not less than ten nor more than fifty dollars, or imprisoned not less than ten nor more than thirty days.

"Section 3. That this act shall be in force from and after the first day of September, 1891.

"Ratified March 5, 1891."

BUREAU OF ANIMAL INDUSTRY.—The liver fluke described by Francis in Bulletin No. 18 of the Texas Station, for which the name *Distomum texanicum* is proposed, is considered by Dr. C. W. Stiles identical with *Fasciola americana*, Hassall, which is probably the same as the *Distomum magnum* described some years ago by Bassi (*Amer. Vet. Rev., March, 1892*).

QUEENSLAND.—Bulletin No. 12, November, 1891, of the Department of Agriculture, Brisbane, contains an article on butter and cheese making by J. Mahon. Bulletins Nos. 4, October, 1890; No. 7, March, 1891; No. 9, May, 1891; and No. 13, December, 1891, contain descriptive notes on a considerable number of species of plants found in Queensland, by F. M. Bailey, the colonial botanist.

Ammonium chloride in carnallite.—The presence of nitrogenous compounds in Stassfurt potash salts has recently been recognized. Ammonium chloride was some time ago found to occur frequently in rock salt and in the manufactured products. W. Diehl found 0.01 per cent of ammonium chloride in crude carnallite, and 0.015 per cent in artificial carnallite. He says that in the concentration of carnallite brines a deposit is sometimes formed containing 80 to 90 per cent of ammonium chloride. More recently Neimke, of Leopoldshall, reports finding 0.8 per cent of ammonium chloride in artificial carnallite. White carnallite furnishing 22 per cent of muriate of potash contained 0.25 to 0.27 per cent of ammonium chloride, while the colored salt, with 18 per cent of muriate of potash contained only about 0.09 per cent of ammonium chloride; and the artificial carnallite made from the white salt contained 0.8 per cent. According to a very exact determination on a large number of samples of the Neustassfurt salt the crude carnallite contains up to 0.08 and the artificial up to 0.012 per cent of ammonium chloride. Concerning the origin of this ammonia, it has been suggested that it may be traced to organic materials present at the time the salt beds were formed, which by putrefaction yielded ammonia.

Lime on clay soils.—The beneficial effects of an application of lime to clay soils is explained by M. Johnstone (*Naturw. Rundschau, 1891, p. 323*) as follows: Clay is a product of the decomposition of silicates which contain alkalis and alkaline earths, besides aluminium. Thus a clay derived from feldspar might contain the hydrated silicate of aluminium plus potassium silicate (or sodium or calcium silicate). Clay particles of this composition lose their potash when treated with carbonic acid water. The author's experiments indicated that the resulting potash compound was a carbonate when an excess of carbonic acid was present, and a soluble silicate when insufficient carbonic acid was present. If lime is present in the latter case it unites with the silicic acid and the potash is freed to combine with any other available acid forming a salt useful to the plant. Hence, the action of lime on clay consists in combining with the silicic acid and setting the potash free.

Milk cake.—Wilhelm Rehnström of Sweden proposes to utilize the skim milk from the cream separator for the preparation of a feeding cake for animals from the casein it contains. The process is briefly described as follows: The precipitated casein is dried, ground, mixed with various nitrogenous feeding stuffs, and pressed into cakes. These cakes, it is claimed, furnish an exceptionally valuable feeding stuff for milch cows and other animals. The process is said to have been patented in several countries.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING FEBRUARY, 1892.

Farmers' Bulletin No. 6.—Tobacco, Instructions for its Cultivation and Curing.

DIVISION OF CHEMISTRY:

Bulletin No. 31.—Proceedings of the Eighth Annual Convention of the Association of Official Agricultural Chemists.

WEATHER BUREAU:

Monthly Weather Review, November, 1891.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Record, vol. III, No. 7, February, 1892.

DIVISION OF BOTANY:

Contributions from the U. S. National Herbarium, vol. III, No. 1, February 25, 1892.—Monograph of the Grasses of the United States and British America.

DIVISION OF STATISTICS:

Report No. 92 (new series), January and February, 1892.—Report upon the Numbers and Values of Farm Animals; Freight Rates of Transportation Companies.

BUREAU OF ANIMAL INDUSTRY:

Sixth and Seventh Annual Reports, 1889 and 1890.

DIVISION OF VEGETABLE PATHOLOGY:

Farmers' Bulletin No. 5.—Treatment of Smuts of Oats and Wheat.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING FEBRUARY, 1892.

AGRICULTURAL EXPERIMENT STATION OF THE AGRICULTURAL AND MECHANICAL COLLEGE OF ALABAMA:

Bulletin No. 30, November, 1891.—Apples, Pears, Peaches, and Plums.

Bulletin No. 31, November, 1891.—Irish Potatoes and Sweet Potatoes.

Bulletin No. 32, November, 1891.—Corn, Wheat, and Oats.

CANEBRAKE AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 13, December, 1891.—Corn.

ARKANSAS AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 17, October, 1891.—Grapes, Strawberries, Raspberries, and Plums.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF CALIFORNIA:

Annual Report, 1890.

Bulletin No. 96, January 25, 1892.—Sulphuring in Fruit Drying; Fig Trees at the Experiment Stations; Notes on Persian Palms.

COLORADO AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 17, October, 1891.—Fruit Interests of the State.

Bulletin No. 18, December, 1891.—Index of the First Seventeen Bulletins of the Station.

Special Bulletin A, January, 1892.—Subjects Investigated by the Experiment Station.

The Delaware Agricultural Experiment Station:

Third Annual Report, 1890.

Bulletin No. 9.—Creamery Studies of Methods and Machinery; Creameries as a Business.

Georgia Experiment Station:

Bulletin No. 16, February, 1892.—Cotton—Fertilizer, Culture, and Variety Tests.

Agricultural Experiment Station of the University of Illinois:

Bulletin No. 18, November, 1891.—Dairying Experiments.

Iowa Agricultural Experiment Station:

Bulletin No. 15, November, 1891.—Sugar Beets; Injurious Insects; Soiling Experiment; Time of Sowing Grass Seed; Winter Wheat; Best Varieties of Oats; Fertilizers.

Kansas Agricultural Experiment Station:

Bulletin No. 25, December, 1891.—Experiments with Sorghum.

Louisiana Agricultural Experiment Station:

Bulletin No. 13 (second series).—Sweet Potatoes.

Maine State College Agricultural Experiment Station:

Annual Report, 1891, part I.

Maryland Agricultural Experiment Station:

Bulletin No. 8, March, 1890.—Some Feeding Trials.

Bulletin No. 12, March, 1891.—Pig Feeding,

Massachusetts State Agricultural Experiment Station:

Circular, January, 1892.—Analyses of Concentrated Feeding Stuffs and Commercial Fertilizers.

Hatch Experiment Station of the Massachusetts Agricultural College:

Meteorological Bulletin No. 37, January, 1892.

Experiment Station of Michigan Agricultural College:

Bulletin No. 80, January, 1892.—Fruits.

Mississippi Agricultural Experiment Station:

Bulletin No. 17, December, 1891.—Insects Injurious to Stored Grain.

Bulletin No. 19, January, 1892.—The Southern Tomato Blight.

Agricultural Experiment Station of Nebraska:

Bulletin No. 19.—Farm Notes for 1891.

New Jersey Agricultural Experiment Stations:

Special Bulletin M, November 23, 1891.—Field Experiments with Soil and Black Rots of Sweet Potatoes.

Special Bulletin N, November 30, 1891.—Insects Injurious to the Blackberry.

New York Agricultural Experiment Station:

Bulletin No. 37 (new series), November, 1891.—Investigations of Cheese.

Bulletin No. 38 (new series), January, 1892.—Oyster Shells as Food for Laying Hens.

Bulletin No. 39 (new series), January, 1892.—Feeding Experiments with Poultry.

Cornell University Agricultural Experiment Station:

Bulletin No. 37, December, 1891.—Sundry Investigations Made during the Year.

North Carolina Experiment Station:

Thirteenth Annual Report, 1890.

Fourteenth Annual Report, 1891.

Bulletin No. 80*a*, October 1, 1891.—Synopsis of the Published Work of the Botanical and Entomological Division of the Station.

Bulletin No. 81, December 15, 1891.—Feeding Cotton-Seed Hulls and Meal for the Production of Beef.

Bulletin No. 81*a*, December 31, 1891.—Meteorological Summary for North Carolina, November and December.

Bulletin No. 82, January 15, 1892.—Fertilizer Analyses and the Fertilizer Control.

North Dakota Agricultural Experiment Station:

Bulletin No. 3, October, 1891.—Diseases of Sheep.

Bulletin No. 4, December, 1891.—Potato Scab and Possibilities of Prevention; A Disease of Beets Identical with Deep Scab of Potatoes; Hastening the Maturity of Potatoes.

Ohio Agricultural Experiment Station:

Bulletin vol. IV, No. 9 (second series), December, 1891.—The Apple Scab; Spraying of Orchards.

The Pennsylvania State Agricultural College Experiment Station:

Annual Report, 1890, part II.

Bulletin No. 18, January, 1892.—Notes on New and Old Varieties of Orchard Fruits and Small Fruits.

South Carolina Agricultural Experiment Station:

Fourth Annual Report, 1891.

Texas Agricultural Experiment Station:

Fourth Annual Report, 1891.

Bulletin No. 18, October, 1891.—Liver Flukes.

Bulletin No. 19, December, 1891.—Corn Fodder.

Agricultural Experiment Station of Utah:

Second Annual Report, 1891.

Virginia Agricultural and Mechanical College Experiment Station:

Annual Report, 1891.

Bulletin No. 11, October, 1891.—Vegetables.

Washington Agricultural Experiment Station:

Bulletin No. 1, December, 1891.—Announcements.

West Virginia Agricultural Experiment Station:

Bulletin No. 18, September, 1891.—Commercial Fertilizers.

Bulletin No. 19, November, 1891.—Your Weeds and Your Neighbors.

Wyoming Agricultural Experiment Station:

Annual Report, 1891.

U. S. DEPARTMENT OF AGRICULTURE

OFFICE OF EXPERIMENT STATIONS

A. W. HARRIS, DIRECTOR

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EXPERIMENT STATION RECORD.

Vol. III. ISSUED APRIL, 1892. No. 9.

EDITORIAL NOTES.

Lines of meteorological work in which the agricultural colleges and experiment stations can profitably engage are pointed out by M. W. Harrington, chief of the Weather Bureau, in Experiment Station Bulletin No. 10, recently issued by this Office. Since these institutions are as a rule rightly located at a distance from the railroads, telegraph, and telephone centers, it is impracticable to make them a part of the network of telegraphic weather stations, from which are sent the daily reports of observations required for the weather map and its accompanying predictions. This leaves them free to carry on meteorological work of a more scientific character and of more permanent value. The nature of this work is outlined by Professor Harrington in the introduction to the bulletin as follows.

"This is the work of special investigation into meteorologic and climatic problems, which requires long-continued and patient observation combined with a high order of ability in planning observations and experiments and in discussing them when once made. They afford a field for the display of skill and talent which is not surpassed in any other branch of science, and the surroundings of the experiment station and agricultural college are very favorable for carrying them on. Among these are included such problems as the distribution of temperatures within such heights in the air and depths in the soil as are occupied by animal and plant life and the changes of temperature with the hour of day, with the season, with the weather, and with the topography; the problems of air drainage; the occurrence of frosts and protection from them; the distribution of moisture; the problems of condensation and evaporation of water in the air; the solar and terrestrial radiations and the disposition of them; the action of the meteorologic elements on organic life and the reactions of life on them; the actions and reactions of weather, climate, and soil; the precipitation of the moisture of the air and the disposition of it.

"Another field which these institutions could probably occupy is that of the collection of data when no great haste is required and the mails fill the need. This is the case for general meteorologic phenomena, where the material is to be used for study, not for immediate prediction. Thunderstorms have been long studied in this way and with excellent results. The same method may be pursued for ice storms, hailstorms, tornadoes, and for secondary storms generally. To be successful a special meteorologic service for the season must be formed by correspondence. If the area selected is small enough the observers can be so thickly scattered that no phenomenon of importance will escape them, and yet the volume of data collected will not be too large to be digested and discussed by the meteorologist of the station or college. This is a matter of great importance, and experience abroad has shown that a country like Bavaria can be covered with so close a network of voluntary observers that practically no local storm escapes them. This country should be thoroughly covered by such local and special services, especially during the warm season, when secondary storms are most common and most distinctive. The necessary expense involved is that of correspondence, postage, and clerk hire, and that of providing at least a few of the correspondents with instruments.

"The investigations mentioned so far can be better carried on from agricultural institutions than elsewhere; there remains a class which contains problems often of the highest agricultural interest, but which can be conducted by any competent person who has the necessary data at his command. These are the problems of climatology, whether geographic, as of States, cities, or natural topographic areas; or of productions, as of the cotton or corn area; or of special climatological features, as of drouths or special winds. Generally the data necessary are in the possession of the National Weather Bureau, or, through its publications, in public libraries or in the hands of private meteorologists. Generally, too, they are in the libraries of the agricultural colleges. Where the necessary means exist there is no more promising field of study, and it affords the advantage of presenting collected data instead of requiring years of preliminary work in gathering them."

Some of the colleges and stations are already carrying on work on some of the topics suggested in this bulletin. It is hoped that these institutions will soon be able to devote more attention to this subject and that many others will in the near future find it practicable to begin investigations in one or more of these lines. By thus raising the grade of their meteorological work and bringing it into direct relation with their other researches in the sciences on which agriculture depends, it is believed that these institutions can make this branch of their work of great value to their several localities and at the same time contribute to the advancement of scientific and practical meteorology, by which the interests of all classes of our people are promoted.

The account on page 640 of investigations at Halle and elsewhere of the effects of fermentation upon the composition and digestibility of wet feeding stuffs is interesting in its bearing upon the question of the chemical changes in green fodder in the silo.

Recent investigations have made it clear that bacteria and other so-called organized ferments are very active in the silo, that the chemical changes which they bring about are complex and variable, and that the effect upon the digestibility and nutritive value of the compounds may be very disadvantageous. The feeding value of the compounds affected by these ferments may be diminished in four ways: (1) A considerable quantity of nutritive material may be lost by decomposition. The amount of this loss may be either inconsiderable or very large, according to the nature of the fermentation. (2) Where the fermentation is accompanied by evolution of heat the potential energy of the resulting products in the silage will be less than that of the original compounds by the equivalent of the amount of heat evolved. (3) The more soluble and easily digestible products are in general the ones most subject to decomposition and hence the material which remains unacted upon may be less digestible than the original material. The experimental results bearing upon this phase of the general question are, however, somewhat conflicting. (4) Products may be formed which are positively detrimental.

In the present state of our knowledge we are able to speak of these things only in a general way, but enough is known to make it certain that a thorough study of fermentations, such as those which take place in the silo, is greatly needed. The beginnings already made in this direction in American and European stations and in biological and chemical laboratories of other institutions are in the right direction, but to get the definite and reliable results which are so pressingly needed nothing less than the most patient and thorough work of the specialists in bacteriology and biological chemistry will suffice.

Here is a field of inquiry which presents manifold attractions to the investigator. It is comparatively new, the research needed is of the highest order as viewed from the standpoint of abstract science, and the results promise to be of the greatest practical value.—[W. O. A.]

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Alabama College Station, Bulletin No. 29, November, 1891 (pp. 23).

GRAPES, RASPBERRIES, AND STRAWBERRIES, J. S. NEWMAN AND J. CLAYTON.—In view of the interest in the subject which has been excited in Alabama through the work of the station, general directions for grape culture are given in this bulletin. There are also tabulated data for 58 varieties (including 10 of the Muscadine type) of grapes planted in 1886 and 77 varieties planted in 1889. Delaware, Ives, Perkins, Concord, and Wyoming Red (early) have proved the most desirable as standard varieties. Among varieties of the Muscadine type Mish and Memory are especially commended.

A list is given of 11 blackcap and 16 red varieties of raspberries tested at the station since 1886. Of the blackcaps, Souhegan and Shaffer Colossal have done reasonably well when partially shaded. The field culture of blackcap varieties is not practicable in the climate of the station. Of the red varieties, Turner (especially commended), Cuthbert, Golden Queen, and Thompson Early Prolific have been successfully grown.

Sixty-four varieties of strawberries, named in a list, have been grown at the station since 1886. The following are recommended as most worthy of culture in Alabama: Sharpless, Wilson, Belmont, Bubach, Eureka or No. 1001, and Haverland.

Alabama College Station, Bulletin No 30, November, 1891 (pp. 15).

APPLES, PEARS, PEACHES, AND PLUMS, J. S. NEWMAN.

Apples.—In March, 1885, 45 varieties were planted at the station. Observations on these, made from time to time since 1886, are tabulated. Most of the varieties which proved successful were Southern seedlings. The following are especially recommended: Winesap, Limber Twig, Horn, Simmons Red, Astrachan Red, Elgin Pippin, Ben Davis, Carter Blue, and Kittageskee.

Pears.—In 1885, 34 varieties of the European type and 6 of the oriental were planted. Tabulated data of observations on these varieties are given. Very many of these have been destroyed by pear blight.

Among the European varieties, Duchess de Angouleme, Seckel, and Winter Nelis have been conspicuous for resisting the blight. Of the oriental varieties, Keiffer and Le Conte have proved the most valuable.

Peaches.—A list of 37 varieties planted in 1885 is given, with data regarding time of ripening. A previous report on these varieties was made in Bulletin No. 11 of the station (see Experiment Station Record, vol. II, p. 8).

Plums.—To compare the effects of different stocks on the longevity of the Wild Goose variety, there were planted in 1885 on peach stocks, seedling plum roots, and plum cuttings, 36 trees (12 on each stock) of this kind. November 23, 1891, there were living, in good condition, on the peach roots 8, on seedling plum roots 3, and on plum cuttings 1 of the trees planted. "Several varieties of peaches budded upon cuttings of the Brill plum have proved very satisfactory."

Alabama College Station, Bulletin No. 31, November, 1891 (pp. 8).

IRISH AND SWEET POTATOES, J. S. NEWMAN AND J. CLAYTON.—Tabulated data are given for an experiment in which 9 varieties of Irish potatoes were planted on plats where manure was applied in three different ways—on and under manure scattered in the furrow, and on manure scattered in the furrow and mixed thoroughly with the plow. The results, on the average, favored planting under the manure. The largest yields were given by Burbank Seedling, Peerless, and White Star varieties. In an experiment in which different methods of cultivation were used for Peerless potatoes, half or full bed culture gave larger results than level culture or mulching between the rows. Whole potatoes of the same variety gave much larger yields than three, two, or one-eye pieces.

Large sweet potatoes used for seed yielded 136 bushels per acre, while small potatoes yielded only 99 bushels.

Alabama College Station, Bulletin No. 32, November, 1891 (pp. 10).

CORN, WHEAT, AND OATS, J. S. NEWMAN AND J. CLAYTON.—Tabulated data are given for 18 varieties of corn. "On one half of the space occupied by each variety two stalks were left to each hill and one stalk on the other half." The yield was uniformly larger from the hills containing two stalks. Blount Prolific, Experiment Station Yellow, and Clayton Bread were the most productive varieties. The last 2 also gave the largest yield in ordinary field culture where 6 varieties (not including Blount Prolific) were compared.

The tabulated results of experiments in top-dressing Ewing and Mexican Rust-Proof oats with various fertilizers indicate that nitrate of soda (150 pounds per acre) somewhat increased the yield. Kansas and Texas Rust-Proof oats compared on fourth-acre plats gave nearly the same yields per acre.

Notes and tabulated data are also given for 14 varieties of winter wheat. De Rieti (red) and Richelle de Naples (white), from seed imported from France by this Department, gave promising results.

Alabama Canebrake Station, Bulletin No. 13, December, 1891 (pp. 8).

EXPERIMENTS WITH CORN, W. H. NEWMAN, M. S.—These were with fertilizers on drained and undrained land, and with peas and melilotus as soil renovators, in continuation of the experiments reported in Bulletin No. 10 of the station (see Experiment Station Record, vol. II, p. 473). The results for 1891, as described in notes and tables, confirm those of the previous year in indicating that drainage is more profitable than the application of fertilizers on "black slough" bottom land, and that peas and melilotus furnish the cheapest and best means for improving the canebrake lands.

California Station, Annual Report, 1890 (pp. 329).

ANALYSES OF SOILS (pp 23–50).—Analyses of 49 samples of soil from the Sierra foothills, Great Valley, Coast Range, and southern California.

ANALYSES OF WATERS (pp. 51–82).—Analyses of 64 samples of water from streams, lakes, springs, common wells, and artesian wells.

ANALYSES OF ROCK, CLAY, MARL, PEAT, AND GYPSUM (pp. 83–86).—Analyses of phosphate rock, soft limestone, clay, cement rock, clay and limestone, marl, peat, and gypsum.

ALKALI (pp. 87–105).—This includes the synopsis of a lecture delivered at a farmers' institute by E. W. Hilgard, Ph.D., on alkali, its nature, causes, and repression; analyses of 11 samples of alkali; and a report by M. E. Jaffa, PH. B., on further experiments on the reactions between alkali sulphates, calcic carbonate, and free carbonic acid.

[A sample of alkali from Pleasant Valley], a whitish powder accumulating by the evaporation of the waters of the valley, consists chiefly of sulphate of soda (Glauber's salt) with small amounts of carbonate of soda (sal soda) and common salt. The waters of the streams contain 119 grains per gallon of this [former] salt and are thus rendered unfit for domestic use. * * * [The following is the composition given of a sample from Kern Island, Kern County], a surface crust heavily charged with soluble salts, from the effects of surface evaporation.

Potassium sulphate	9.52
Sodium sulphate (Glauber's salt)	82.96
Sodium chloride (common salt)	0.48
Sodium carbonate (sal soda)	0.40
Magnesium sulphate (Epsom salt)	0.50
Magnesium carbonate	0.13
Calcium phosphate	0.20
Calcium sulphate (gypsum)	0.10
Oxide of iron and alumina	0.30
Silica	1.34
Organic matter and chemically combined water	4.07
Total	100.00

This sample is thus seen to consist almost entirely of the sulphates of soda and potash, chiefly the former. There is not a sufficient amount of carbonate of soda to render the salts injurious to the soil, under proper conditions of subsoil and tillage. The percentage of potash is so large that the salt might be utilized as a fertilizer upon lands deficient in that element of plant food. The presence of phosphates also adds to the value of the salts as a direct fertilizer.

[Alkali crust from San Bernardino County.]

The alkali amounts to 9.593 per cent of the crust, and consists of—

Organic matter and water	4.358
Soluble in water	93.928
Insoluble in water	1.666
Silica	0.048
	100.000
The soluble portion of the alkali consists of—	
Sulphate of potash	4.988
Sulphate of soda (Glauber's salt)	62.733
Sulphate of magnesia (Epsom salt)	0.561
Carbonate of soda (sal soda)	14.886
Chloride of sodium (common salt)	10.770
	93.928
The insoluble portion of the alkali consists of—	
Sulphate of lime (gypsum)	0.145
Carbonate of lime	0.465
Carbonate of magnesia	0.649
Peroxide of iron (as carbonate of iron)	0.407
Total	1.666

The amounts of soluble sulphates and of common salt in the above crust are extremely large, and of course destructive to vegetation, but being easily soluble in water they can be readily removed by proper drainage. But the presence of so large an amount of carbonate of soda (nearly 15 per cent of the salt, or 1.4 parts per hundred of the soil) makes the matter a far more serious one, especially when it is remembered that a percentage of less than one tenth of one per cent is sufficient to injure vegetation, by rendering the soil caustic and corrosive, and by dissolving out the humus. The only antidote would be a large application of gypsum and the thorough drainage of the land.

INVESTIGATION OF CALIFORNIA ORANGES AND LEMONS, G. E. COLBY, PH. B., AND H. L. DYER (pp. 106–115).—A reprint of Bulletin No. 93 of the station (see Experiment Station Record, vol. III, p. 78).

APRICOTS (p. 115).—Analysis of 1 sample.

SUGAR BEETS (pp. 115–123).—Analyses of 20 samples of sugar beets raised in different sections of the State, and in three instances of the soil on which the beets were grown. Beets with as high as 16.8 per cent of cane sugar and 87.1 per cent purity were raised.

COMPARATIVE TANNIN ASSAYS OF CAÑAIGRE ROOTS GROWN IN CALIFORNIA, C. S. BONNER (pp. 123–126).—"The cañaigre is the root of a species of dock (*Rumex hymenosepalum*) which grows wild in Texas, Arizona, New Mexico, southern California, and parts of Mexico. It has

been long used for tanning purposes by the Indians, and also of late years by the tanneries of those districts."

The roots from which the samples were taken were planted in 1884. They contained from 38.5 to 41.8 per cent of tannin in the dry matter. Examination of different parts of the root shows that "the inside parts of the root give more tannin than the outside. * * * The smaller roots contain less of the thick and heavy woody tissue, and more of the soft growing parts, and therefore give a large percentage of tannin." The tests indicate that "the roots may be gathered at any time after the plants have ceased flowering."

PRESERVATIVE FLUIDS FOR FRESH FRUITS AND THE SULPHURING OF DRIED FRUITS, E. W. HILGARD, PH. D. (pp. 126–133).—A reprint of Bulletin No. 86 of the station (see Experiment Station Record, vol. II, p. 98).

FERTILIZERS, E. W. HILGARD, PH. D. (pp. 134–143).—This includes papers on The Use of Fertilizers in California, reprinted from Bulletin No. 88 of the station (see Experiment Station Record, vol. II, p. 272); and on The Fertilizing Value of Grease Wood, reprinted from Bulletin No. 94 of the station (see Experiment Station Record, vol. III, p. 373); and analyses of fish guano, dried hog tankage, fertilizers, sulphur refuse, and guano from Sophia Island.

REPORT ON FIELD WORK AT THE CENTRAL STATION, E. J. WICKSON, M. A. (pp. 147–149).—An outline account of the work performed during 1890.

THE BOTANIC GARDEN, E. L. GREENE (pp. 149, 150).—Brief statements regarding preliminary work in the establishment of a general botanic garden in addition to the garden of economic plants begun a number of years ago.

It is proposed first of all to form a living collection or garden of the native trees, shrubs, and herbaceous plants of the State of California, gathering in at the same time, as rapidly as our limited facilities will permit, those of our neighboring States on the Pacific coast. No region of the world has a more interesting or varied native vegetation than this coast, and scarcely more than a beginning has been made at the scientific study of it as a whole. The moderate climate of Berkeley, exempt from all extremes of heat and cold and humidity and drouth, is just that which must prove adapted to the growing of the greatest variety of plants in the open air and without irrigation.

OLIVE CULTURE AND OLIVE OIL (pp. 150–177).—This includes notes on varieties of olives by W. G. Klee, reprinted from Bulletin No. 85 of the station (see Experiment Station Record, vol II, p. 11), with brief statements regarding seedling olives grown at the station, and articles by L. Paparelli on the Ripening, Picking, Assorting, and Conservation of Olives (read before the Fruit Growers' Convention at Santa Cruz, November 21, 1890); Proper Fertilizers for Olive Trees (published in the *California Fruit Grower*, March 14, 1891); Notes on California Olives, their Adaptation and Oils, reprinted from Bulletin No. 92 of

the station (see Experiment Station Record, vol. II, p. 629); Tests for Olive Oil Adulteration (part of a paper read before the Olive Growers' Association at San Francisco, July 8, 1891).

The following statements are taken from the article regarding the fertilizing of olive trees:

Analysis of the olive tree.

	Wood.		Leaves.	Fruit.
	Large branches.	Small branches.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Ash	0.941	0.963	2.506	1.422
Water and organic matter	99.059	99.037	97.494	98.578
	100.000	100.000	100.000	100.000
Composition of the ash.				
Potash	19.165	20.492	50.260	60.744
Soda	2.250	4.778	1.614	2.225
Lime	57.574	50.412	46.155	16.282
Magnesia	3.652	6.760	4.424	3.770
Oxide of iron	3.275	3.284	1.414	0.096
Phosphoric acid	11.684	12.437	10.470	8.334
Sulphuric acid	2.119	1.160	4.754	1.104
Silica	0.281	0.677	0.649	5.670
Chlorine	Trace.	Trace.	0.260	1.581

The experience of many years has proved to the European olive growers that trees growing in calcareous lands are the richest in mineral matter and give oil of the best quality; these olives are always richest in potash. The other ingredients are not considered so important, because the small quantity needed is always found in the soil. It seems also that an excess of lime existing in the soil facilitates the assimilation of the potash by the plants; therefore we may say that the olive needs a calcareous soil, rich, especially in potash, and also not deficient in phosphoric acid. Besides the ingredients mentioned, it is important to observe that there was a large quantity of nitrogenous matter contained in the fruit, the kernels being richest in this respect. This fact is not only important in regard to the crop, but also to reproduction by seed. Without a sufficient supply of nitrogen the kernels would not be completely developed, and therefore the few plants that we should obtain from them would not be vigorous, and would not make fine trees, even after being grafted with good varieties. * * *

From the investigations of Professor Hilgard, we know that nearly all the soils of California may be considered as abundantly supplied with lime; almost the same can be said for the potash, while phosphoric acid is more sparingly represented. Nitrogen is also found in small quantities only, except in some localities where there is a certain amount of nitrate. According to calculations made from my analyses, it appears that a large, robust olive tree, well cared for, in a soil suited to its development, takes away yearly in its growth and crop the following proportions of the principal ingredients.

	Grams.	Pounds.
Potash	460	1.016
Nitrogen	909	2.006
Phosphoric acid	171	0.458

In brief, it may be said that California soils are naturally very well adapted to olive culture, provided we increase, by the use of manure, their proportion of nitrogen and phosphoric acid in localities where these ingredients are deficient. * * *

Being so fortunate as to have good soils in this State, we should provide for maintaining their fertility; and in order to obtain constant success in olive culture I would recommend the use of a compound fertilizer, more convenient to the olive growers than high-priced special fertilizers. A very good fertilizer may be prepared by making a compost of stable manure, olive leaves and twigs, black waters obtained in pressing oil, vegetable ashes (especially those from the olive), a little sheep-corral manure or human fæces, scraps of horn, bone, and offal from the slaughter-house, and wool and leather waste. We should also never neglect the residue from the olives themselves, on account of valuable substances they contain, both in the natural state and as ashes. Oil cake, for example, contains 9.71 per cent of nitrogenous matter, and its ashes 8.94 per cent of potash and 9.45 per cent of phosphoric acid. All the substances mentioned or as many of them as are at hand must be well mixed together and well cured in the manure pit, adding also earth and leaf mold found in the neighborhood of the farm. * * *

I would say, first of all, that the olive tree, planted in a soil which suits it, does not need much manuring, and that in order to obtain oil of a superior quality the manuring must never be abundant, because while abundant manuring gives a large crop, the quality of the oil resulting is inferior and difficult to keep. * * *

For level lands dig a shallow trench around the trunk at a distance varying according to the age and size of the trees. That trench should be nearly 16 inches in depth and distant from 2 to 6½ feet from the trunk. In order to aerate the layer of soil where the roots are, the trench should remain open for about 40 days in case of compact soils, but only for 15 days in case of light ones. After that time the bottom of the trench is covered with a thin layer of fine earth, and upon it is placed the well-cured manure. The trench is then filled with half of the earth excavated and the rest is used when the soil around the trunk settles. For hill lands the manure is placed in a round hole made in the soil on the upper side of the tree, so that the water in filtering through the soil carries the nutritive juices into contact with the roots below. The quantity of the manure to be given varies with the age and condition of the tree, the nature of the soil and of the manure, and finally according to the methods of culture.

Of compost prepared more or less as indicated above, we may give from 40 to 60 pounds to each tree, supposing the conditions of soil and climate be favorable; but the grower should vary the quantity according to the special conditions of his location, and also according to his experience, if he has grown olives for several years. We must, moreover, maintain the equilibrium of vegetation by pruning proportionately to the quality of the soil or the quantity of the manure employed. If the manuring was abundant, little pruning ought to be given; if, on the contrary, the manuring was slight, pruning ought to be heavier. In this way the vegetative equilibrium is maintained and the production will not suffer. It is impossible to indicate precisely the time for manuring. Autumn is the time for cold soils, where manure will decompose very slowly, so that at the starting of vegetation the trees may find the nutritive ingredients ready for use. Spring is the proper time for warm, very permeable soils, or those subject to be washed by rain. If such soils were manured in autumn very little nutriment would remain at the commencement of growth in spring. Annual manuring is of course the most rational and should be calculated so as to replace, as nearly as possible, the ingredients withdrawn by the preceding crop.

Fiber plants for California (pp. 177–192).—This includes articles on the Production of Ramie, by E. W. Hilgard, Ph. D.; Composition of the Ramie Plant, by M. E. Jaffa, Ph. B.; and Flax for Seed and Fiber, by E. J. Wickson, M. A., reprinted from Bulletins Nos. 90 and 94 of the station (see Experiment Station Record, vol. II, p. 474, and vol. III, p. 371).

GRAPES FROM PERSIA AND ITALY, L. PAPARELLI (pp. 193–195).—Brief notes on a number of Persian varieties recently received by the station and on Italian varieties imported by the station, as reported in Bulletin No. 91 of the station (see Experiment Station Record, vol. II, p. 629).

THE BLACK WATTLE (pp. 195, 196).—This article was prepared from notes by the late W. G. Klee, and gives estimates from Australian sources showing the profitableness of the culture of the black wattle (*Acacia decurrens*) for the tannin contained in its bark.

DISTRIBUTION OF SEEDS AND PLANTS, E. J. WICKSON, M. A. (pp. 196–201).—The statistics of the distribution of seeds and plants by the station for 5 years (1886–90). The plan of distribution is that explained in Bulletin No. 84 of the station (see Experiment Station Record, vol. I, p. 190).

GRASSES AND FORAGE PLANTS FOR CALIFORNIA, E. J. WICKSON, M. A. (pp. 201–220).—This includes brief extracts from the correspondence received by the station regarding the grasses and forage plants which it has distributed and general statements regarding the adaptability of the plants to California, from which the following summary has been prepared:

Japanese wheat grass (*Agropyrum japonicum*) has done well on the experimental plats at the station, growing vigorously and resisting drouth. It was distributed for the first time in 1889, so that its general value for the State has not yet been demonstrated.

Texas blue grass (*Poa arachnifera*) has made a good growth when planted from "root sets" and will probably do well "in fairly loamy soils in regions of moderate rainfall."

Schrader brome grass (*Bromus unioloides*) has shown itself to be well adapted to many parts of California. While some localities are too dry for it and it is to a certain extent dependent on volunteer seeding for its permanence, it nevertheless "resists drouth wonderfully, and under moderately favorable conditions the roots live from year to year."

Hungarian or awnless brome grass (*Bromus inermis*) is likely to please the grower better than Schrader brome grass in the central coast region of the State, but is not so hardy.

Tall oat grass (*Arrhenatherum avenaceum*) starts quickly after the fall rains and makes an excellent winter growth. In loose soils it roots deeply and holds its verdure late in the summer, but is more sensitive to drouth than the brome grasses. It seems suitable for northern California and the other Pacific coast States. Mixtures of this grass with alfalfa and with orchard grass should be tried.

Many-flowered millet (*Milium multiflorum*) requires careful management to get a good stand, and has not generally proved satisfactory, though it grows well on the experimental plats at the station.

Rye is largely grown for winter feeding of stock in the foothill regions of the State and at points along the east side of the Great Valley.

Among European varieties distributed by the station, St. John's Day has proved best adapted to local conditions. It makes a heavy and strong growth.

Kaffir corn and millo maize have been found valuable, and by many are thought to be superior to the "old variety of *Sorghum vulgare*, known as dhoura but commonly designated in this State as Egyptian corn, which has for many years proved of great value in the State, both when cut green as summer food for stock and when allowed to ripen its seed, which is widely used for poultry, and to some extent as a substitute for barley as food for horses."

Johnson grass (*Sorghum halepense*) has been found to be a great pest in cultivated ground and very difficult to eradicate. "As to the value of Johnson grass as stock food, there is some difference of opinion, arising, to some extent at least, from the stage of growth at which different growers have used it. It is undoubtedly acceptable to animals when the growth is young and succulent. It is also readily eaten when growing with alfalfa, and it is believed to obviate bloat, which is common among animals turned into alfalfa fields."

Sainfoin (*Onobrychis sativa*) has not done well at the station, and the evidence regarding its value elsewhere in the State is conflicting.

Snail clover (*Medicago turbinata*) is a native of southwestern Spain, and has been introduced into California by the station as a plant having the advantages of burr clover (*M. denticulata*) and in addition a smooth pod. The reports concerning it received by the station are generally favorable. "It is evident that its growth will be freest and most satisfactory where moisture is abundant, and that in exceptionally dry and hot situations its growth may be small and the plant of little account. It also shows liability to injury by frost in some localities."

Black medic (*Medicago lupulina*) is recommended only for moist, retentive soils in the upper coast regions of the State.

Japan clover (*Lespedeza striata*) has proved a failure in California.

Tangier pea (*Lathyrus tingitanus*) has been distributed on a limited scale since 1889, with favorable results.

Tagasaste (*Cytisus proliferus*, var. *albus*) in California grows as a tall shrub with woody stem and branches and is without special value as a forage plant.

Jersey kale at the station "has produced green fodder at the rate of 16 tons per acre, starting quickly again after cutting." It seems to have quite a range of adaptability to California conditions, but has so far been mostly grown on a small scale as green fodder for poultry and the live stock kept for domestic purposes.

Salt bushes of the genus *Atriplex*, imported from Australia as food for sheep and goats, do not seem to have been of much service in California.

MISCELLANEOUS PLANTS SENT OUT FROM THE CENTRAL STATION, C. H. SHINN (pp. 221–236).—This consists of extracts from reports of

correspondents, with brief general statements, which may be summarized as follows:

Seedling date palms (*Palma dactylifera*) have been planted with varying success. "As an ornamental lawn or avenue tree, the date palm (including the Canary Island species, *Phœnix canariensis*) has a much wider range in California than has been ordinarily understood, and sooner or later it will be planted extensively for these purposes as far north as the head of the Sacramento Valley."

Huasco grape cuttings have been widely distributed, and this variety is recommended "especially in districts where the Muscat is an uncertain bearer, as in portions of San Diego and the Sacramento Valley. Especial success is reported from Santa Barbara, San Luis Obispo, Colusa, Shasta, and Yuba."

Olives are attracting much attention. The Manzanillo variety seems to be hardier than the Nevadillo, but not so hardy as the Mission.

The camphor tree seems well established. "There have been but few failures that can be attributed to frost. The tree thrives on a great variety of soils and over the larger part of the State. The most serious cause of failure is evidently the blighting north winds and any extremely hot weather. All who used proper precautions in shading and sheltering until the trees were thoroughly established have managed to save them."

The true carob of southern Europe and Asia Minor is likely to prove a popular shade and ornamental tree for dry, rocky situations.

The cork oak of Spain is worth planting, particularly on light soils in the Sierra foothills. It is difficult to transplant this tree.

Bamboos sent out by the station have been grown with varying success. The Ringal and Metake species seem to have done better than *Thamnocalamus spathiflorus*.

Mulberry trees, especially "*Morus alba*, *M. nigra*, *M. multicaulis*, *M. rubra*, and *M. japonica*, with their subvarieties, are adapted to the greater part of the State." The best growers and the handsomest trees of the group are the Japanese *Nagasaki* and *Lhoo*.

New Zealand flax (*Phormium tenax*), with its strong fiber, is "valuable for every gardener and farmer, who can use strips of the leaves for many purposes," but the plant does not thrive in a very hot and dry climate.

The melon tree (*Carica papaya*) is too tender for any except the warmest regions of the State.

"The strawberry tree (*Arbutus unedo*) appears to have done well in most counties of the State," especially near the coast.

"Of the various maples that are natives of the country east of the Sierras, none except the *Acer negundo*, or box elder, has ever equaled our native California species. The most valuable of the native species is the *Acer macrophylla*, which in suitable soil and within the range of the moist ocean winds, is of enduring and rapid growth. It can be

highly recommended as an avenue and shade tree. The timber also is quite valuable."

PLANTS ALONG NORTH STRAWBERRY CREEK, UNIVERSITY OF CALIFORNIA, C. H. SHINN (pp. 236–238).—Brief accounts of trees, shrubs, and vines growing on a portion of the grounds of the University of California.

WEEDS OF CALIFORNIA, E. W. HILGARD, PH. D. (pp. 238–252).—Brief statements regarding the extent to which the following species have become troublesome weeds in California: White mustard (*Brassica rapa*),* black mustard (*B. nigra*),* radish (*Raphanus sativus*),* hedge mustard (*Erysimum officinale*), shepherd's purse (*Capsella bursa-pastoris*), *Tropidocarpum gracile*, celery, carrot, fennel, Fuller's teasel, knotweed (*Polygonum aviculare*),* *Rumex crispus*,* *R. pulcher*,* *R. acetosella*,* *Amaranthus retroflexus*, *A. albus*, *Chenopodium album*, *C. bonus henricus*, *C. vulvaria*, *Portulacca oleracea*, *Claytonia perfoliata*, *Calandrinia menziesii*, *Silene gallica*,* *Stellaria media*,* *Spergula arvensis*, *Mollugo verticillata*, *Malva parviflora*,* *Erodium cicutarium*,* *E. moschatum*,* *Geranium carolinianum*, *Oxalis corniculata*, *Rhus diversiloba*,* *Pteris aquilina*, burr clover (*Medicago denticulata*),* sweet clover (*Melilotus indica*),* sand lupine (*Lupinus formosus*),* native licorice (*Glycyrrhiza lepidota*),* tarweed (*Chamæbatia foliolosa*), evening primrose (*Œnothera ovata*), *Epilobium paniculatum*, *Megarrhiza* spp., *Cucurbita fœtida*, tocalote (*Centaurea melitensis*),* prickly tarweed (*C. solstitialis*),* *Cotula vulgaris*,* barley grass (*Hordeum jubatum*), *H. murinum*,* *Silbyum marianum*,* *Xanthium strumarium*,* *X. spinosum*,* *Sonchus oleraceus*,* *Senecio vulgaris*,* *Erigeron canadense*, *Cichorium intybus*, *Matricaria discoidea*, *Chrysanthemum Leucanthemum*, *Madia sativa*,* *Hemizonia luzulæfolia*,* *H. elegans*, *Helianthus annuus*,* *H. californicus*, *Troximon* spp., *Hypochæris* spp., *Achyrachæna mollis*, *Matricaria occidentalis*, *Anagallis arvensis*,* *Apocynum cannabinum*, *Asclepias fascicularis*, *A. fremonti*, *A. eriocarpa*, *Gomphocarpus tomentosus*, *Erythræa muhlenbergii*, *Gilia squarrosa*, *Phacelia tanacetifolia*, *Amsinckia intermedia*,* *A. lycopsoides*,* *Convolvulus californicus*,* *C. arvensis*,* *Cuscuta trifolii*, *C. salina*, *Solanum nigrum*, *Datura stramonium*, *D. meteloides*, *Nicotiana attenuata*, *Veronica peregrina*, *Scrophularia californicus*, *Mimulatus lyratus*, *Orthocarpus purpurescens*, *Stachys bullata*, *Brunella vulgaris*, *Trichostema* sp., *Verbena officinalis*, *Plantago major*, *P. mollis*, *P. lanceolata*,* *Setaria glauca*,* *Urtica holoserica*, *U. urens*, *Euphorbia lathyrus*, *Eremocayrus setigerus*, *Anemopsis californica*, *Sisyrinchium bellum*, *Calochortus invenustus*, *Juncus effusus*, *Bromus secalinus*, *B. mollis*, *B. sterilis*, *Lolium temulentum*,* wild oats (*Avena fatua*), *Poa annua*, alkali grass (*Distichlis maritima*), eagle fern.

While the above enumeration seems, at first sight, to present the weed question as somewhat formidable in respect to the number of species concerned, yet, as a matter of fact, "getting into the grass," that constant bugbear of the Eastern farmer, confronts the Californian cultivator only in exceptional seasons; and with ordinary and intelligent care, adapted to the nature of the local weeds, he can usually rest from

* Decidedly troublesome.

the weed war from June to November, or whenever the rains happen to set in. In the older cultivated regions, in fact, the extirpation has frequently been so complete that in the absence of the supply of vegetable matter usually furnished by plowing-in of weeds, the green manuring of the clean orchards and vineyards is being seriously taken in hand.

SOME CALIFORNIA WEED SEEDS, H. P. DYER (pp. 252–266, figs. 23).—Descriptive notes on the following species of weeds, with illustrations of their seeds: *Raphanus sativus, Capsella bursa-pastoris, Eschscholtzia crocea, Erodium moschatum, Geranium carolinianum, G. dissectum, Silene gallica, Claytonia perfoliata, Calandrinia menziesii, Malva parviflora, Medicago denticulata, Lupinus micranthus, Trifolium gracilentum, Agoseris plebeia, A. hirsuta, Calais lindleyi, Hypochœris radicata, Sonchus oleraceus, Matricaria discoidea, Senecio vulgaris, Gnaphalium purpureum, Stachys bullata, Amsinckia intermedia.*

TREES PLANTED ON MOUNT HAMILTON, K. MCLENNAN (p. 267).—A brief report on a number of species of trees planted in 1889 and 1890.

REPORT ON THE SIERRA FOOTHILL SUBSTATION (pp. 268–277).—This includes a brief account of improvements at the substation near Jackson, Amador County, and notes on orchard fruits and nuts, by C. H. Shinn, and reports on tests of varieties of grain and experiments with fertilizers on barley grown for hay by G. Hansen.

Tests of varieties of grain.—Tabulated data are given for 45 varieties of wheat, 19 of barley, 12 of oats, 5 of rye, and 5 of spelt grown in 1890 and 1891 on red and granite soils.

Experiments with fertilizers on barley grown for hay.—An account of an experiment on a soil consisting for the most part of decomposed granite, which analysis showed to be deficient in phosphates and humus. Nitrate of soda and bone meal, singly and in combination, and a "complete fertilizer" were compared with no manure. The yield was increased in every case by the application of fertilizers and was doubled where nitrate of soda and bone meal were used together.

REPORT ON THE SOUTHERN COAST RANGE SUBSTATION (pp. 278–286).—A brief account of the work at the substation near Paso Robles, San Luis Obispo County; brief descriptive notes on orchard fruits, nuts, and grapes, by C. H. Shinn; and tabulated data on tests of varieties of cereals, by R. D. Cruickshank. The latter included 42 varieties of wheat, 17 of barley, 10 of oats, 5 of rye, and 4 of spelt.

REPORT ON SAN JOAQUIN VALLEY SUBSTATION, C. H. SHINN (pp. 287–291).—Brief notes on orchard fruits, nuts, wheat, barley, rye, oats, spelt, grasses, clovers, cotton, ramie, jute, sugar beets, sorghum, etc. The land at this substation, which is located at Tulare, consists of "alkali" soils of different grades and is representative of a vast area at present considered almost valueless for agricultural purposes. The experiments in progress are made with a view to determining what plants are adapted to such soils or what are the best methods for improving them.

REPORT ON SOUTH CALIFORNIA SUBSTATION, C. H. SHINN (pp. 292–300).—This substation was established in 1890 near Pomona, Los Angeles County. A brief account of the substation was given in Experiment Station Record, vol. II, p. 135. The present report includes statements regarding the work and equipment of the substation; notes on orchard fruits, grapes, sorghum, and other plants; and a list of the varieties planted, as follows: 71 of grapes, 46 of apples, 70 of pears, 10 of cherries, 56 of plums, 15 of prunes, 49 of peaches, 14 of apricots, 6 of nectarines, 14 of almonds, 22 of figs, 20 of olives, 16 of oranges, 7 of lemons, 7 of other citrus fruits, 8 of Japanese persimmons, 3 of pomegranates, a number of mulberries, etc.

SCHOOL INSTRUCTION IN ENTOMOLOGY, E. J. WICKSON, M. A. (pp. 303–307).—By an act of the California legislature approved March 15, 1887, practical entomology was included among the branches to be taught in the public schools. The present article contains suggestions to teachers regarding methods of instruction and abstracts from reports of school officers showing how the law is being carried out. It appears that efforts are being made to give attention to this subject in the schools of many localities, and that on the whole there is satisfactory progress in the introduction of this new branch into the school curriculum. There is great need of an elementary manual on economic entomology as a guide to teachers and pupils in connection with oral instruction and object lessons.

SPRAY AND BAND TREATMENT FOR THE CODLING MOTH, C. W. WOODWORTH, M. S. (pp. 308–312).—Notes and tabulated data are given for experiments in which Paris green (1 pound to 160 or 320 gallons of water), London purple (1 pound to 80 or 160 gallons of water), and white arsenic (1 pound to 320, 480, or 640 gallons of water) were sprayed on apple and pear trees three times (in most cases) within 30 days after May 3. During this period there was very little rain. The most satisfactory results were obtained with Paris green, 1 pound to 160 gallons of water, by which a saving of two thirds of the fruit which would otherwise have been injured, was effected. The band treatment destroyed less than half of the larvæ, and then only after they had completed their injury to the fruit. Lists of varieties of pears and apples are given, classified with reference to the amount of injury which they received from the codling moth.

VARIATION IN HESSIAN FLY INJURY, C. W. WOODWORTH, M. S. (pp. 312–318).—Tabulated data for observations on the amount of injury by the Hessian fly (*Cecidomyia destructor*) in 1886, 1887, and 1889 on 125 varieties of wheat. Volo and Washington Glass were the only varieties not attacked. The following were especially free from attack: Bearded wheat from Missoyen, Forelle, Palestine, Polish, Blue Glass, Common March, Diamond, and Egyptian Imported. The following were comparatively uninjured: Bearded Macaroni, Big Long-Bearded Club, Egyptian, Genoese Winter, Greek Atlanti, Hunter White, Improved

Circassian, Nicaragua, Nonette Lausanne, Red Club, Russian Red-Bearded, and White Club. Forty-five per cent of the early varieties and 67 per cent of the late varieties were badly infested. "Sixty per cent of the early varieties gave fair or good crops in spite of the flies, while only 37 of the late varieties did so." Observations with reference to the relations of early and late planting to injury by the fly indicate that no rule can be laid down on this matter.

THE USE OF GASES AGAINST SCALE INSECTS, F. W. MORSE (pp. 319–326).—A summary of information on this subject collated from the reports of experiments by the author in 1887 and 1888, published in Bulletins Nos. 71, 73, and 79 of the station.

FINANCIAL STATEMENT (p. 329).—This is for the fiscal year ending June 30, 1891.

Connecticut State Station, Bulletin No. 110, December, 1891 (pp. 12).

The bulletin includes an article on Canada ashes and a request for samples of Indian corn. The station desires to make a collection of the varieties of Indian corn which have been grown in Connecticut for a term of years and of new varieties which are considered valuable.

CANADA ASHES (pp. 2–8).—Analyses are given of 13 samples of unleached Canada ashes sent to the station for examination. Remarks are made on the sampling of ashes and on substitutes for unleached ashes.

It is safe to say that the carbonates and phosphates of potash, magnesia, and lime constitute the entire agricultural value of ashes. Can we, then, provide 110 pounds of potash, 39 of phosphoric acid, and 1,220 of carbonate of lime in fine condition in some other form cheaper than ashes ?

An application in the late fall of 20 bushels of burned oyster-shell lime (40 pounds to the bushel), at 12 cents per bushel, would supply as much lime as a ton of ashes at a cost of $2.40; 500 pounds of cotton-hull ashes in addition would cost $8.75 and supply as much or more potash than a ton of Canada ashes and very considerably more phosphoric acid. The weight of these two things would be 1,300 pounds as against 2,000 pounds of Canada ashes, which involves a saving in cartage; the cost $11.15, a little less than Canada ashes cost on the average.

The comparison is here made with ashes of excellent quality. With ashes of lower grade, which are more common in our markets to-day, the showing for the substitute would be much more favorable.

If cotton-hull ashes are not available, in their place may be used 220 pounds of high-grade sulphate of potash and 150 pounds of some cheap steamed bone, like Peter Cooper's Bone, and 800 pounds of oyster-shell lime, the three costing $11.10.

The above-named mixtures would be close imitations of superior wood ashes, not only as respects the kinds and proportions of fertilizing elements, but also as to the forms or combinations of these elements. Still cheaper, and in most cases probably no less effective, would be a mixture of 800 pounds (20 bushels) of burned oyster-shell lime with 150 pounds of Peter Cooper's Bone and 220 pounds of muriate of potash, the total weighing 1,170 pounds and costing $9.45.

The oyster-shell lime being caustic should be put on in the late fall or early spring, and being fine and pulverulent it will soon be converted into carbonate.

Stone lime could be used instead of oyster-shell lime, but being in hard lumps

would require slacking before being sown. The sulphate or muriate of potash and bone are best applied in spring.

It is hoped that our farmers may make thorough trial of these substitutes, which are considerably cheaper than the average of Canada ashes, quality as well as price being taken account of.

Delaware Station, Bulletin No. 9, 1890 (pp. 32).

CREAMERY STUDIES OF METHODS AND MACHINERY, C. L. PENNY, M. A. (figs. 4).—The account of the creamery studies is prefaced by an illustrated description of the butter extractor, by A. T. Neale, with which the tests described below were made. The tests with this machine and with the De Laval separator were carried out at a creamery, under the supervision of the author.

Butter from sour and sweet cream (pp. 12–24).—Six trials are reported in making sour-cream butter and four in making sweet-cream butter. From nearly 900 to over 2,500 pounds of milk containing from 3.67 to 4.28 per cent of fat, were taken for the separator trials, which occurred at different seasons of the year. In all cases the cream was separated from the milk by a De Laval separator. In six cases the cream was ripened for from 72 to 92 hours at about 50° F. and then churned. In the other four cases it was churned immediately after being separated. To diminish the loss of butter by this method the suggestion of J. A. Myers of the West Virginia Station, to "run the buttermilk through the separator and churn the cream thus obtained," was followed. The butter from this "secondary cream" was of poor quality.

The results are tabulated for separate trials, including analyses of the butter. The percentage of fat in the whole milk recovered in the butter ranged from 90.24 to 96.4 and averaged 93.34 per cent with the sour-cream process, and ranged from 86.66 to 90.95 and averaged 88.41 per cent with the sweet-cream process. The buttermilk from the sour cream averaged 0.48 per cent of fat, and that from the sweet cream contained from 1.61 to 2.69, averaging 2.22 per cent of fat; that is to say, with the sour-cream process on an average 1.5 per cent of the fat in the total whole milk was lost in the buttermilk, and in the sweet-cream process from 6.08 to 9.85 per cent.

It will appear from the showings of the two processes, as would be expected, that they differ essentially in the yield of the churn; the difference in the work of the separator is within the limits of its fluctuations. The efficiency of the sour-cream process is 4.93 per cent higher than that of the sweet-cream process; but the buttermilk in the latter case contains 5.37 per cent more butter-fat than in the former. * * * A comparison of butter made by the two processes will show that the amounts of water and curd are both a little greater in the sour cream than in the sweet-cream butter, and the acidity twice as great in the former as in the latter. The mechanical condition of sweet-cream butter is less favorable. It lacks the firmness, the "stand-up" quality of the other, and it is considered by creamery men not to stand shipment, handling, or warm weather so well. Its taste is peculiar to those unaccustomed to it, but to some people it is preferable. In a word, however, sweet-cream butter is less profitable to make and harder to sell than the sour-cream butter.

The butter extractor (pp. 24–32).—Ten trials were made with this apparatus.

The extractor is designed to make butter directly from sweet whole milk, and is essentially a separator and a continuous churn combined. The process differs from the sweet-cream process only as to the time the operation lasts (probably not more than a second for any particular drop of milk), and in the lower temperature at which the milk is separated. The work is done by means of a revolving bowl like that of a separator, a device for churning the cream inside of this bowl and another for catching the butter underneath. The milk, which is fed at the top, is first separated into cream and the cream is churned almost instantly to butter. The butter is received at once into a tub of ice water, from which it is taken and worked immediately, and again worked on the following day.

The results of the two best trials and the analyses of the butter are tabulated. In these 816 and 1,034 pounds of milk were used, containing 3.79 per cent of fat. The percentage of the total fat recovered in the butter was 84.6. In the two trials the average rate of work per hour was 960 pounds of milk and 38.65 pounds of butter.

A comparison of the efficiency of the extractor with that of the sour-cream and the sweet-cream process shows it to be 8.74 per cent below the former, and 3.81 per cent below the latter. The difference between the extractor and the sweet-cream process is chiefly due to the greater mechanical losses on the part of the extractor and in smaller degree to less perfect separation and less perfect churning.

To determine how far the higher yield of the sour-cream process is due to difference in the churnability of sour cream and sweet cream, the experiment was tried September 8, and repeated November 28, of taking sour or ripened cream, separated by the De Laval separator, and ready for churning by the sour-cream process, adding thereto the corresponding quantity of fresh separated milk, and running it through the extractor just as fresh whole milk. The results seem to confirm the conclusion that butter is more easily and completely separated from sour cream than from sweet cream.

The trial on sour cream made September 8 gave an efficiency of 86.18 per cent—an increase of 1.58 per cent over the sweet milk runs, and the trial on November 28 gave 85.28 per cent. The falling off in the second instance is due to the imperfect separation done by the extractor on that day.

Hence it seems clear that if the extractor could work on sour cream it might easily increase its efficiency from 1 to 2 per cent. * * *

An experiment was further tried November 28 to ascertain if the large quantity of butter left in the wash water could not in part be recovered by running the wash water through the extractor just as the whole milk. The result was 80.08 per cent without this addition and 81.74 per cent with it—an increase of 1.66 per cent. Although the gain is considerable it is doubtful if this would be a useful practice, inasmuch as the butter thus recovered appears to be decidedly peculiar. It retains after working, over 27 per cent of water; it lacks the cohesive quality of the other butter; and it is whiter in color and less firm. It seems so far inferior to the other butter that it would be impossible to work up the two together without great injury to quality.

As to the quality of the extractor butter, a point of more importance to the creamery man even than the yield, all that was said of sweet-cream butter may be repeated. In some instances strictly first-class butter, in the opinion of experts, was made when the examination was made at a rather low temperature. The "grain" is considered excellent, fully as good as that of the best grades of sour-cream butter. The taste is the same as that of the sweet-cream butter, to some people agreeable and even preferable to the other. So far as could be observed,

however, the majority of people prefer the sour-cream butter. It is said, and doubtless justly, that this is largely a matter of education, and that after a longer trial the unbiased taste always inclines to the product of the extractor. When properly made and kept in a cool place this butter rivals in firmness and appearance the best of the other makes. It is not considered, however, to stand handling, warm weather, or shipment so well. The analyses given show no notable quantitative difference from the other kinds, except that there is usually considerably more water. The acidity is practically the same as that of the sweet-cream butter made in the churn. * * *

[It is believed that the use of the extractor would result in no saving of power or hand labor,] hence one feels justified in concluding that if the quality of the butter be left out of account, the extractor, as at present, offers no substantial advantage that is not outweighed by defects, and that it would not allow any saving in expense over the process it is designed to supplant. * * * Its future development is probably a question of the relative merits of sweet-cream butter and sour-cream butter. If experience and an educated taste shall finally favor the former, the extractor may be expected to take the place of the separator and the churn, but unless the decision shall fall in that direction it is doubtful if the new device ever comes into general use.

Florida Station, Bulletin No. 16, January 1, 1892 (pp. 14).

EXPERIMENTS WITH VARIOUS CROPS AND WITH SILAGE, J. P. DEPASS.—Accounts are given of experiments in 1891 with corn, rice, sugar cane, Texas blue grass, and cotton. The season was unusually dry. Experiments with composts on corn and cotton indicated that the application of iron in the form of copperas was beneficial on the sandy soil of the station. The stripping of corn for fodder decreased the yield somewhat and was of doubtful advantage. Suggestions are made regarding hay making and the cultivation of corn with reference to the repression of the weevil. Rice on old, sandy land did not do well even when heavily fertilized, but was more successfully grown on bottom land. Sugar cane was grown with comparative success on "fresh hammock," but has proved a failure on old and high land. Texas blue grass (*Poa arachnifera*) has done well at the station during the past three seasons and promises to be valuable for winter pasturage in Florida. Experiments with a cheap wooden silo have indicated the superiority of corn for silage and the desirability of cutting up the material before storage. The usefulness of the silo in Florida is doubtful.

Georgia Station, Bulletin No. 15, December, 1891 (pp. 40).

FERTILIZER EXPERIMENTS ON CORN, R. J. REDDING (pp. 91–104).

Nitrogen experiment (pp. 91–99).—This is a repetition on the same plats of the experiment of the previous season, described in Bulletin No. 10 of the station (see Experiment Station Record, vol. II, p. 550). The nitrogenous fertilizers—nitrate of soda, sulphate of ammonia, dried blood, and cotton-seed meal—were used alone and combined with muriate of potash and superphosphate in single, double, and triple rations. There were 25 plats of about three fortieths of an acre each. The analyses

are given of the superphosphates, nitrate of soda, sulphate of ammonia, dried blood, cotton-seed meal, muriate of potash, kainit, and barnyard manure used, and also the yields of shelled corn per acre, as tabulated, for 1890 and 1891. As in the previous year, there was evidence of unevenness of the soil, which gave rise to inconsistency in the yields when the same fertilizers were used in increasing amounts on different plats. The largest yield of corn (30.92 bushels) occurred with the use of a double ration of sulphate of ammonia with potash and superphosphate. With a triple ration of ammonium sulphate with the same amounts of potash and superphosphate, the yield was about a third less than with the double ration. The next largest yield was with a triple ration of nitrate of soda. Except in the case of ammonium sulphate the yield of corn increased with increase of nitrogenous fertilizers.

The yield was in all cases larger when potash and surperphosphates were applied with the nitrogenous fertilizers than when the latter were used alone. In general the results indicated that "nitrogenous manures increased the yield of corn on the soil covered by the experiments; that nitrogen alone, regardless of the source, was more effective in increasing the yield of corn than either phosphoric acid or potash alone or both combined; but that when a large amount of fertilizers was to be applied to corn it was best to add all three of the elements." A formula is given for a mixture containing cotton-seed meal to be used as a fertilizer for corn.

General fertilizer experiment on corn (pp. 99–102).—The object of this experiment was to determine the effect of applying varying quantities of each of the three elements. One acre of very poor, gravelly soil which had been in corn the previous year was divided into 35 plats. The basal fertilizer consisted of a mixture of 156 pounds of superphosphate, 19.4 pounds of muriate of potash, and 32.4 pounds of nitrate of soda per acre. This was applied on 4 plats. In separate cases the single ingredients, two ingredients, and all three were doubled, 4 plats receiving the same fertilizer mixture in each case. Two plats remained unmanured. The amount and cost of fertilizers applied and the yields of shelled corn are tabulated. The yields were small on all the plats, ranging from about 4.5 to 10 bushels of shelled corn per acre.

It is quite evident that—

(1) The soil was a very poor soil for corn.

(2) The soil was deficient in all three of the elements—phosphoric acid, potash, and nitrogen.

(3) It was particularly deficient in nitrogen, because nitrogen invariably produced the most marked increase in the yield.

(4) Phosphoric acid was next in order of deficiency, since its effectiveness in increasing the yield was next after that of nitrogen.

(5) Potash was least effective and was least needed.

Intercultural fertilizing (pp. 103, 104).—This was a repetition of an experiment reported in Bulletin No. 10 of the station (see Experiment Station Record, vol. II, p. 551), but was on different plats. The fertilizers

applied were superphosphate 312 pounds, muriate of potash 39 pounds, and nitrate of soda 65 pounds per acre; or cotton-seed meal 143 pounds, superphosphate 286 pounds, and muriate of potash 37 pounds per acre. These were applied either all before planting or in two or three separate portions, one portion before planting and the remainder during the growing season. "On the whole the results do not show any decided advantage in intercultural fertilizing." These indications agree with those of the previous season.

EFFECT OF PULLING FODDER, R. J. REDDING (pp. 104–106).—This experiment was similar to one described in Bulletin No. 10 of the station (see Experiment Station Record, vol. II, p. 551), and was made to observe the effect on the final yield of corn of stripping the leaves from the stalks on one half of each of 16 plats, the fodder being carefully cured and dried. The results are tabulated.

The plats from which the blades were stripped yielded 23.9 bushels of shelled corn per acre. Those from which the blades were not taken gave a yield of 27.3 bushels per acre—a loss of 3.4 bushels per acre as the result of pulling the fodder. But the yield of fodder was 270 pounds per acre, at a cost for pulling and curing of 81 cents. In other words, there was a loss of 3.4 bushels, equal to 190.4 pounds of corn, and a gain of 270 pounds of fodder. * * * The result does not justify any modification of the conclusion drawn last year, which is as follows: The strongest argument against the practice is the meager results in fodder compared with the amount of labor involved. The same labor employed in mowing grass or any good forage crops, even without the use of improved harvesting machinery, would yield vastly greater results.

DEEP VS. SHALLOW CULTURE OF CORN, R. J. REDDING (pp. 106, 107).—This trial was made in connection with the experiment in pulling fodder described above, 8 plats receiving deep and 8 shallow culture. The results are tabulated. "The average yield of the shallow-culture plats was 26.1 bushels of shelled corn per acre, while that of the deep-culture plats was 25.1; but the advantage of the shallow culture becomes still more manifest when the cost of the extra labor involved in deep culture is considered."

VARIETY TEST OF CORN, R. J. REDDING (pp. 107–109).—Tabulated notes on 17 varieties.

CRUSHED COTTON SEED VS. COTTON-SEED MEAL AND HULLS, R. J. REDDING (pp. 109–111).—In this test amounts of crushed cotton seed and cotton-seed meal and hulls furnishing like amounts of fertilizing ingredients, were applied in connection with superphosphate and muriate of potash on plats containing three rows 209 feet long. The average yield of corn on 4 plats receiving crushed cotton seed was 29.2 bushels, and on 4 plats receiving cotton-seed meal and hulls 28.9 bushels per acre, indicating no advantage of the crushed seed over the ground and extracted meal.

COMPOSTING IN THE HEAP VS. COMPOSTING IN THE FURROW, R. J. REDDING (pp. 111, 112).—On 4 plats of corn a mixture of 346 pounds each of superphosphate, barnyard manure, and crushed cotton seed,

composted 6 weeks prior to planting, was applied. On 4 other plats the same mixture was applied without composting. Each plat contained 3 rows 209 feet long. The tabulated yields indicate that "there is nothing gained by previously mixing and fermenting barnyard manure, cotton seed (crushed), and superphosphate in the proportion given, in comparison with applying the same ingredients directly and separately to the soil."

A TALK FOR FARMERS, R. J. REDDING (pp. 112–115).—Popular remarks on the use of fertilizers and on light *vs.* heavy manuring.

SMALL FRUITS, G. SPETH (pp. 115–128, figs. 21).—General directions for the culture of strawberries, blackberries, and raspberries, with brief descriptions of varieties suitable for Georgia and brief statements regarding the diseases of small fruits.

Maryland Station, Bulletin No. 8, March, 1890 (pp. 16).

FEEDING OLD MILCH COWS FOR BEEF, A. I. HAYWARD, B. S. (pp. 3–11).—To compare the cost of fattening old and young cows for beef, a trial was made with two cows 9 to 10 years old or over—one Jersey and one Ayrshire, and two others 5 to 6 years, both Jerseys. The trial lasted from January 30 to April 3, 9 weeks. The food for all consisted of corn meal or corn-and-cob meal, wheat middlings, oil meal, and Hungarian hay or corn stover, the rations being adjusted to suit the appetite of each cow. The old cows were weighed each week and the young cows daily. The amounts of food and water consumed and the gains in live weight are tabulated for each animal.

As these cows, with one exception, were at their best in the eighth period or week, it seems fairest to consider the results of the first 8 weeks of the trial. By calculating the cost of food consumed during this period, at the local market rates of the several articles, it is found that for lot 1 [old cows] it cost $20.65 to produce a gain of 105 pounds of beef, or almost 20 cents a pound; for lot 2 [young cows] it cost $21.95 to produce 209 pounds, or about 10½ cents a pound. At ruling prices for beef both lots were fed at a loss, although the loss was twice as great for the older cows and may be called disastrous in this case.

The difficulty of accurately determining the gain in live weight of the animals from single weighings taken weekly is well illustrated by this experiment, and the errors likely to result from depending on single weekly weighings are calculated and stated in a table.

FEEDING HEIFERS ON SILAGE ONLY, H. E. ALVORD, C. E. (pp. 12–14).—An account is given of a trial lasting from January 30 to April 3, in which two pure-bred Ayrshire heifers, both with calf, were fed exclusively on silage made from a mixture of corn, sorghum, and soja beans. This silage had a nutritive ratio of 1:10.3. It was fed *ad libitum* (about 40 pounds per animal daily). The food eaten and the fluctuations in live weight are tabulated.

"The silage described was in this case a good and sufficient food for 2-year-old heifers during the winter, just before first calving and at

time of calving. It proved to be more than a 'maintenance' ration in this trial."

WORKING OXEN FED FOR BEEF, H. E. ALVORD, C. E. (pp. 15, 16).—This is a report of the gains in live weight and the production of manure by two large working oxen, 6 years old, from January 25 to May 20. The feeding stuffs used were corn meal, cotton-seed meal, hay, rye straw, and molasses. The two oxen gained over 600 pounds in live weight during the 116 days of feeding. They were sold at 7 cents per pound live weight. The calculated profits from the transaction, reckoning the food at current prices and allowing for the manure produced, was $33.42, or a "net profit of 15 per cent on investment in 4 months."

Maryland Station, Bulletin No. 12, March, 1891 (pp. 14).

SUMMER TREATMENT OF PIGS, H. E. ALVORD, C. E., AND A. I. HAYWARD, B. S. (pp. 147–160).—To test the question, "Is it profitable to feed pigs well in the summer, or may they be allowed to run with little or no care and yet without much loss?" two experiments were made, one in 1889 and the other in 1890.

Trial of 1889 (pp. 147–152).—The trial included two lots of six pigs each from two litters, farrowed November 18 and December 20, 1888, and lasted from June 1 to December 30. From June 1 to October 21 lot 1 were kept in pens and fed swill, to which a little wheat middlings was occasionally added, and lot 2 were allowed to run in the woods, no food being given them. From October 21 to December 30, the time of slaughtering, both lots were fed alike for fattening, receiving whole corn *ad libitum*, and from 1 to 1.25 pounds of wheat bran per animal daily. The tabulated data include the amounts and cost of food eaten, the gains in live weight, the dressed weights, and the shrinkage in dressing.

(1) The penned pigs made the greater gain, especially during the summer, were the heavier when killed, and showed less shrinkage.

(2) The pastured pigs were the better feeders while fattening and gained more weight during this period.

(3) The two lots were practically alike in ratio of food to weight gained and in the cost of producing a pound of pork.

(4) The penned pigs did not pay well for their extra care in summer.

Trial of 1890 (pp. 152–160).—This trial was with two lots of five pigs each, and the pigs were about a month older than those used in 1889. They averaged about 89 pounds each in weight. The trial lasted from May 5 to January 6. From May 5 to October 21 lot 1 was pen-fed, receiving "Patapsco" middlings, weeds, and refuse, and lot 2 ran in the woods. From October 21 to January 6 both lots were pen-fed, receiving whole corn, Patapsco middlings, and boiled potatoes in amounts to suit the appetites of the pigs. The results for each lot are tabulated.

(1) The penned pigs made the greater total gain, gross weight, and dressed weight, but the greater gain was confined to the summer months.

(2) The pigs which ran in the woods 24 weeks, without cost, gained nothing during this period, but were the better feeders while fattening and gave the greater gain at this time.

(3) The "pastured" lot, after fattening began, made a pound of pork at less cost than the penned lot.

(4) The penned pigs did not pay well for their special summer care.

(5) The pigs running out in summer showed by their anatomy, as well as by their appetite and growth, greater vitality, vigor, and capacity for assimilating food during the fattening period.

(6) The two lots were practically alike in shrinkage when dressed.

Conclusion.—The results of these trials for 2 years indicate that for fall or winter pigs, which are to be killed when about a year old, it is more profitable to let them run in pasture or woodland during the warm months and shift for themselves until within 8 or 10 weeks of killing time than it is to feed them in confinement during the summer.

Massachusetts Hatch Station, Meteorological Bulletin No. 37, January, 1892 (pp. 4).

A daily and monthly summary of observations for January at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

Michigan Station, Bulletin No. 79, January, 1892 (pp. 23).

VEGETABLE TESTS, L. R. TAFT, M. S., AND H. P. GLADDEN, B. S.—This includes descriptive notes and tabulated data on old and new varieties of vegetables, as follows: Bush beans 26, pole beans 10, beets 14, celery 8, cucumbers 10, lettuce 27, peppers 12, radishes 26, squashes 6, tomatoes 37, cabbage 38, sweet corn 26, peas 57.

Among varieties especially commended are the following:

Bush beans.—*Wax beans.*—Cylinder Black Wax, Speckled Wax, Saddleback, and Mammoth Wax. *Green-podded varieties.*—Osborn Forcing, Dakota Soup, Hatt No. 3, and Shah. *For field culture.*—Burlingame, Snowflake, and Hatt No. 2½.

Pole beans.—Challenger, Ford Mammoth, Golden Champion, Golden Cluster, and Old Homestead.

Beets.—Bassano, Blood Turnip, Edmund Blood Turnip, Half Long Blood, Salzer Beauty, Landreth Early, and Lentz.

Celery.—Golden Dwarf, Golden Self-Blanching, and Pascal (new).

Cucumbers.—*For pickling.*—Green Prolific, Long Green, Russian, Parisian, and Everbearing. *For the table.*—Hill White Spine, Pera, and White Japan.

Lettuce.—*For hotbed or summer use.*—Chicago, Tennis Ball, California Butter, Hanson, and Simpson. *New varieties.*—Hothouse (forcing), New York, and White Star.

Radishes.—*Early.*—Ne Plus Ultra, French Breakfast, Wood Frame, Rapid Forcing, and Long Bright Scarlet. *Summer.*—Chartier, Scarlet Short Top, Surprise, and White Summer.

Squashes.—Cocoanut (small) and Sibley.

Tomatoes.—Ignotum is the "best all round" variety; of the new varieties Long-Keeper and Potomac (pink) and Cumberland Red and Mitchell (red) gave the best satisfaction. Plants from green seed had no special advantage over those from ripe seed. Commercial fertilizers did not promote earliness or productiveness. Seven different kinds of trellises were tried with about equally good results. A trellis having four wires, "two on each side of a 6 inch fence board and about a foot apart," was very easily constructed and required the least attention.

Cabbages.—Etampes (very early), Henderson Summer, All Seasons, Fottler Brunswick, Diamond Winter, Marblehead, and Vandergaw.

Sweet corn.—Cory (earliest), Lackey, Leet, Perry, Crosby, Concord, Old Colony, and Mammoth.

Onions, transplanting.—Onions of 3 varieties sown in a hotbed April 10 and transplanted May 16 were much more productive than those sown in the field May 16.

New Jersey Stations, Bulletin No. 85, December 18, 1891 (pp. 12).

FARM PRACTICE AND FERTILIZERS TO CONTROL INSECT INJURY, J. B. SMITH.—A popular article, from the standpoint of the entomologist, showing what means may be taken by the farmer to repress various insect pests without the use of insecticides. The following summary is taken from the bulletin:

Plow late in the fall, whenever possible, and always turn sod at that time when corn is to follow and the land is not too "leachy." Where grass is to be kept longer than usual, harrow in the fall and top-dress with kainit immediately after. Leave fields as clean as it is possible to get them during the winter. Clear off the entire remnants of a crop after harvest, and either destroy it or make such other use of it as may be possible. Keep field and orchard clear at all times, and never allow heaps of rubbish to lie anywhere over winter. In orchards, keep the ground clear of fallen fruit. Whenever possible apply potash in the form of kainit and nitrogen in the form of nitrate of soda, and both as a top-dressing. Plant your crop, whenever possible, so as to either get ahead of or away behind all danger of insect attack. * * * Rotation is an important means of checking increase of insects, by depriving the species of its normal food and either starving it out or forcing it to wander elsewhere.

New York State Station, Bulletin No. 37 (New Series), November, 1891 (pp. 70).

INVESTIGATIONS OF CHEESE, L. L. VAN SLYKE, PH. D. (pp. 647–716).—These investigations were made to study the various conditions which affect the yield, the composition, and the quality of cheese. The questions investigated were: (1) How much fat can be readily worked into cheese? (2) the influence of the percentage of fat in the milk upon the amount of fat and of nitrogenous compounds recovered in the cheese; (3) is the recovery of fat and of nitrogenous compounds more thorough by the stirred-curd process than by the Cheddar process of cheese making? (4) comparative results with commercial and with

homemade rennet extracts; and (5) general changes in composition which take place in the ripening or curing of cheese.

By way of introduction the composition of milk and cheese and the processes of the manufacture of cheese are popularly discussed.

Nine separate experiments were made, eight at the station and one at the factory. Six of these were in making stirred-curd cheese and three Cheddar cheese. "The milk used was mixed milk of various breeds of cows. In some cases it consisted of milk from 2 or 3 days' milkings, but in most cases it consisted mainly of fresh morning's milk mixed with the milk of the previous evening." In the different trials milk was used containing from 2.35 to 6.49 per cent of fat, the desired percentage of fat being secured by skimming or by adding cream. The details of cheese making were varied as to temperature, time allowed for the separate processes, the kind of rennet used, etc.

In each experiment the cheese was made by an experienced cheese maker. Analyses were made at the station of the milk; the first, second, and third wheys; and of the cheese when 7, 21, and 35 days old, respectively. Incidentally it is mentioned that for the determination of the fat in cheese the Babcock test did not give sufficiently accurate results and was discarded for gravimetric methods. The tests of the milk and whey were by the Babcock method.

Full details are tabulated of the process of manufacture, the analytical results, and the yield of cheese. Without going into details, the general results obtained are summarized below under different headings.

Loss of fat, casein, and albumen in cheese making.—The actual amount, as well as the proportion, of milk fat lost in the whey increased gradually, but not uniformly, when the amount of fat in the milk increased.

The average amount of fat lost in the whey in all the experiments was about one third of a pound for 100 pounds of milk, which was about 7.5 per cent of the milk fat. Taking only those experiments which most nearly represented average factory milk, the average amount of milk fat lost was one fourth of a pound for 100 pounds of milk, which was nearly 7 per cent of the milk fat.

While it was true that the loss of fat increased, both absolutely and relatively, when the amount of fat in the milk increased, it was not true that all the additional fat above 4 per cent or even above 5.5 per cent was lost in the whey. * * *

In the comparison made between the stirred-curd and Cheddar processes, the amount of fat lost in the third and fourth experiments is practically the same, the fat in the milk being 3.88 and 3.96 per cent, respectively. In the fifth, sixth, and seventh experiments, when the fat in the milk was about the same, being between 4.7 and 4.8 per cent, the Cheddar process gave considerably better results. That the difference in favor of the Cheddar process in this case was due to the Cheddar process we can not say; changes due to other conditions in the process of manufacture may have made the difference. Before we can draw any definite conclusions in regard to loss of fat in the Cheddar process as compared with the stirred-curd, many other experiments will be needed. * * *

The amount of casein and albumen lost appeared to bear no definite relation to the total amount of casein and albumen in the milk.

The average amount of casein and albumen in the milk in the eight experiments was 3.43 pounds per 100 pounds of milk; of this amount about 23 per cent or about 0.8 pounds was lost.

The irregular variations in the proportion of casein and albumen lost were probably due to variations in the conditions of manufacture.

When the amount of casein and albumen in the milk was nearly the same as or greater than the amount of fat, the loss of fat was least. When the amount of fat became considerably greater than the amount of casein and albumen, then the loss of fat increased. Comparatively large proportions of casein served to hold the fat more completely in the curd, as would be expected.

The amount of fat in the milk appeared in no way to have any influence on the amount of casein and albumen lost in the process of manufacture.

Influence of composition of milk on composition of cheese.—The proportion of fat in the cheese showed a tendency to increase, but not uniformly, when the amount of fat in the milk increased. There were about 24 pounds of fat in 100 pounds of cheese made from the skim milk, while 100 pounds of the cheese made from the milk richest in fat contained about 45 pounds of fat. * * *

Milk containing less than 3 per cent of fat would, on the basis of these experiments, make cheese containing less than 30 per cent of fat. Such cheese would be below the standard required by law in Wisconsin. * * *

The fat exercised a greater influence on the composition of the cheese than any other constituent of the milk.

There appeared to be no relation between the amount of casein and albumen in the milk and the amount of casein and albumen in 100 pounds of cheese. * * *

The proportion of casein and albumen in cheese depends upon the amount of casein and albumen relative to the amount of fat in the milk and not upon the amount of casein and albumen taken alone.

Influence of composition of milk on yield of cheese.—In the experiments described in this bulletin, the increase in the yield of cheese was due to increase of fat more than to any other constituent of the milk. * * *

The yield of cheese increased when the amount of fat in the milk increased, but not uniformly so.

In three experiments the increased yield of cheese was wholly due to increase of fat in the milk, while in the other experiments the increased yield was mainly due to increase of fat in milk.

In several experiments the amount of casein and albumen in the milk exercised no influence whatever upon the increase of yield, while in the other cases its influence was small as compared with that of the fat and even less than the influence of the water retained.

Comparison of the Cheddar and stirred-curd processes.—In one case, when the milk contained about 4 per cent of fat, the proportion of fat lost was the same in both processes; in the other case, when the milk contained nearly 5 per cent of fat, the loss of fat was less in the Cheddar process.

In one case the loss of casein and albumen was 3 per cent less in the Cheddar process than in the stirred-curd process, while in the other case the loss by the Cheddar process was 7 to 9 per cent less than in the stirred-curd process. The causes of these differences were probably due to variations of conditions not in any way related to the processes.

The cheese made by the Cheddar process contained a larger proportion of water and a correspondingly smaller proportion of fat than the cheese made by the stirred-curd process.

No influence appeared to be exerted in regard to the proportion of casein and albumen in the cheese.

In both trials the Cheddar process made a larger amount of marketable cheese, producing 1 pound more of cheese from 100 pounds of milk than did the stirred-curd process.

In the two experiments in which comparison was made, no difference in any respect could be noticed that could be attributed to difference in the rennet extract used.

Changes taking place in the ripening of cheese.—The loss of weight varied for the first 5 weeks from 6.58 pounds to 9.30 pounds for each 100 pounds of cheese.

There was a mechanical loss of fat, the exact amount of which was difficult to determine.

There was practically no appreciable loss of casein during the first 5 weeks.

Analysis of two green cheeses indicated between 1 and 2 per cent of albumen in the cheese.

There appeared to be a general tendency for the insoluble casein to become less in quantity and for the soluble nitrogen compounds to increase.

The soluble nitrogen compounds showed a tendency to increase more rapidly in the cheeses containing the larger amounts of fat.

The acidity showed a marked tendency to diminish as the cheese became older.

A statement is given of the quantity of milk of different composition which was required to make 1 pound of green cheese and of cheese 1, 3, and 5 weeks old. As the cheese shrunk in weight in keeping, the proportion of cheese to milk decreased of course as the cheese became older. The statement is as follows:

Milk required to make 1 pound of cheese.

No. of experiment.	Fat in milk.	Process.	Amount of milk required per pound of cheese when cheese was—			
			Green.	One week old.	Three weeks old.	Five weeks old.
	Per cent		*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1	2.35	Stirred-curd	10.23	10.50	10.79	11.05
2	3.01	......Do	10.34	10.71	11.01	11.29
3	3.88	......Do	9.15	9.48	9.69	9.89
4	3.96	Cheddar	8.19	8.42	8.70	8.89
5	4.70	Stirred-curd	8.44	8.73	8.90	9.03
6	4.73	Cheddar	7.64	7.85	8.08	8.25
7	4.80	Stirred-curd	8.16	8.38	8.76	8.99
8	6.49	......Do	7.28	7.54	7.81	7.99

The investigations are to be continued. In conclusion the author discusses the methods of paying for milk at cheese factories on the basis of quantity alone and on the basis of fat content, and compares the making of whole milk and skim milk cheese.

The method of paying for milk at cheese factories according to the amount of milk delivered regardless of its composition, is unjust to the producers of the better milk. Payment for milk on the basis of the fat contained in it is the best method yet proposed, mainly for three reasons: (1) The milk fat appears to exercise a greater influence upon the composition and yield of cheese than does any other constituent of milk, and therefore forms a just basis for estimating the cheese-producing efficiency of factory milk. (2) Payment for milk according to its fat encourages and induces dairymen to produce a better quality of milk. (3) Payment for fat in milk removes any temptation to adulterate milk.

New York Cornell Station, Bulletin No. 36, December, 1891 (pp. 11).

ON THE EFFECT OF A GRAIN RATION FOR COWS AT PASTURE, I. P. ROBERTS, M. AGR., AND H. H. WING, B. AGR. (pp. 341–351).—Previous experiments on this subject have been published in Bulletins Nos. 13 and 22 of the station (see Experiment Station Record, vol. I, p.

280, and vol. II, p. 369). "In two trials in two seasons we have received no return in milk or butter from feeding a grain ration to cows on good pasture." The present experiment was made on a herd of sixteen cows, which were believed to represent the average conditions of the State more nearly than the herd at the station did. The cows had been accustomed to receive only a moderate grain ration in winter and none in summer. The herd was divided as nearly as possible into two equal lots, lot 1 receiving grain and lot 2 only coarse food. The herd had been turned to pasture April 25. The experiment lasted from May 23 to October 23—22 weeks. The pasture was at no time very luxuriant. "On August 10, the pastures having become dry, both lots began to receive a ration of green corn fodder of about 16 pounds per cow per day. On September 9 the corn-fodder ration was changed to millet, which continued until October 1, when second-growth grass was used; this continued until October 13, when pumpkins began to be fed. The rations of millet and mown grass were about the same in amount as the corn ration; the pumpkin ration was about 47 pounds per cow per day in two feeds."

The milk of each cow was weighed at every milking, and once each week, except at the first, when the intervals were longer, a sample of the mixed milk of the eight cows at two successive milkings was taken for analysis. On the basis of these data the yield of milk and of butter fat for each lot was calculated. The results are tabulated and graphically represented in diagrams. During the 22 weeks lot 1 (grain-fed) produced 22,628.5 pounds of milk, and lot 2 (no grain) 17,697.75 pounds, or a gain of nearly 5,000 pounds of milk by the grain-fed lot. But lot 1 consumed 2,600 pounds of corn meal and 1,300 pounds each of cotton-seed meal and wheat bran, which, reckoned at $20, $24, and $14 per ton, respectively, cost $50.70.

"If we estimate the milk at $1 per 100 pounds, which is rather more than the average returns from cheese factories in this State will warrant, the 5,000 pounds would be worth $50. * * * On the basis of the value of the milk for butter making and estimating that 100 pounds of butter fat in the milk would make 115 pounds of finished butter, which could be sold at 20 cents per pound," the value of 5,000 pounds of milk is calculated as $53.70. Lot 1 gained 166 pounds per cow, and lot 2, 113 pounds. "Of course it might be argued that it is not profitable to feed a dairy herd for increase in live weight, and this is undoubtedly true in general, but with a herd in the spring, thin in flesh, as this one was, the effect of the extra gain in the grain-fed lot on their next season's production must be at least worthy of consideration." The milk of lot 1 averaged 4.67 per cent, and that of lot 2, 4.70 per cent of butter fat.

As pointed out by the authors, the above statement makes no allowance for the saving of the pasture and the increased value of the manure from feeding grain. [Assuming 80 per cent of the fertilizing ingredients of the grain to be recovered in the manure, and allowing 15 cents

per pound for nitrogen, 7 cents for phosphoric acid, and 4.5 cents for potassium oxide, a valuation used by the station on a former occasion, the value of the fertilizing materials from the grain would be $24.35.]

New York Cornell Station, Bulletin No. 37, December, 1891 (pp. 49).

WORK OF CHEMICAL DIVISION, H. SNYDER, B. S. (pp. 357–365).

Determination of fats in fodders by direct weighing of the ether extract and by loss of weight of the substance (pp. 357–360).—A comparison was made on twelve different feeding stuffs of the percentage of fat found by weighing the dried ether extract (as is usually done), and by the loss in weight of the feeding stuff by extraction with ether. The tests were made with the apparatus described by G. C. Caldwell, Ph. D., in Bulletin No. 12 of the station (see Experiment Station Record, vol. I, p. 278), for drying substances in hydrogen and for the extraction of fat, which "serves the double purpose of glass-stoppered weighing tubes and as drying tubes."

The total average by weighing the fat was 0.006 per cent higher than by the loss of weight, a difference which is insignificant.

The tubes are more convenient for drying than flasks, and no additional or expensive drying apparatus is required as for the flasks. The drying of the tubes after the extraction can be done much more quickly and efficiently than drying the flasks, for the gas passes through the substance rather than over its surface, thereby requiring less hydrogen. More than this, the results show that the use of hydrogen in this second drying can be dispensed with.

On the whole, therefore, it is more economical as to time, apparatus, and hydrogen to determine the fats by loss of weight of the substance, while there is no loss in accuracy.

Determination of albuminoid nitrogen (pp. 360–362).—In determining albuminoid nitrogen by means of copper hydroxide and the Kjeldahl method, the author found it necessary to add more potassium sulphide than was called for by the official recommendations for 1890. In comparative tests on silage, in which 20 and 50 c.c. of potassium sulphide were used, results nearly 0.1 per cent higher were secured with 50 than with 20 c. c.

A difference of 0.1 per cent when multiplied by the protein factor would make a difference of over 0.6 per cent of protein, which is too great to be overlooked.

Some change must therefore be made in combining Stutzer's and Kjeldahl's methods.* The following proportions of substance and solutions have given me satisfactory results: Take 0.7 gr. of substance instead of 1 gr., a quantity of copper hydroxide and glycerin solution equivalent to 0.5 to 0.6 gr. of the hydroxide instead of 0.7 to 0.8, and finally 30 c. c. of potassium sulphide instead of 20 c. c.

Drying samples of fresh manures (pp. 262, 263). The drying can be carried on by artificial heat, without loss of ammonia, in the following simple manner: The sampling bottle in which the manure is received is provided with a two-hole rubber stopper. Through one of these holes a glass tube with six or eight holes blown out through its walls is carried to the bottom of the bottle; another tube

*The present official method calls for "sufficient potassium sulphide solution to completely precipitate all copper and mercury."

passes first through the other hole of the stopper and is carried from this bottle through an upright condenser, and then nearly to the surface of a small quantity of standard acid in an Erlenmeyer flask. Hot air is aspirated through the bottle containing the manure and thence through the condenser and Erlenmeyer flask, where all escaping ammonia is caught and can be determined by titration.

This method has been applied to the drying of samples of horse and hog manure with satisfactory results.

Determination of nitrogen in soils (pp. 363, 364).—"In view of the fact that the nitrates and nitrites are separately determined by more delicate methods, and that nothing is gained by the modified Kjeldahl method, while many difficulties are introduced by its use, the direct method is much to be preferred, with a separate determination of the nitrite and nitrate."

Miscellaneous analyses (p. 364).—Analyses of gluten meal, brewers' grains, cotton-seed meal, corn meal, ship stuff, anthers of corn, and pollen of corn.

Sampling milk (pp. 364, 365).—Tests of the fat content of samples taken with a dipper and of mixed samples of the same milk.

SOME NOTEWORTHY WEEDS, A. N. PRENTISS, M. S. (pp. 366–368, fig. 1).—Descriptions of golden hawkweed (*Hieracium aurantiacum*), field chamomile (*Anthemis arvensis*), and beard's tongue (*Pentstemon lævigatus*, var. *digitalis*), with illustrations of the first and third of these species.

VARIATION IN ROOT PRESSURE IN DIFFERENT SPECIES, A. N. PRENTISS, M. S. (pp. 368–371, figs. 2).—"The observations recorded in this article were intended to show the variation in the force of root pressure in different species of greenhouse plants grown in pots and subjected to the same conditions of heat, light, and moisture. The plants were prepared for the experiment by cutting off the stems 3 inches above the ground and attaching a glass tube to the stump by means of a piece of rubber tubing, which was strongly wired at both ends. The height to which the water rose in the glass tube was supposed to show the relative force of root pressure in the several species. The plants were all strong and healthy and apparently in a vigorous condition of growth."

In the following table the results of the experiment are shown, fractions being omitted. In the fourth column the variation in root pressure is reduced to equivalent values, the lowest being taken as the unit.

Kinds of plants.	Total rise of water in the tube.	Average rise of water per 24 hours.	Units of root pressure.
	Inches.	*Inches.*	
Balsam a	97	11	65
Balsam b	49	5	33
Balsam c	61	5	40
Begonia a	65	3	43
Begonia b	57	2	38
Eucalyptus	1.5	....	1
Coleus	15	1	10
Geranium	1.5	....	1

"The length of time in days during which the water continued to rise in the several tubes may be determined approximately by dividing the figures of the first column by those of the second."

DEHORNING, I. P. ROBERTS, M. AGR. (pp. 372–376).—Dehorning has been practiced at the station during the past 6 or 7 years, and though the operation has for the most part been performed by inexperienced persons, no ill effects have followed. Notes and tabulated data are given for five milch cows dehorned November 5, 1891, as compared with seven cows not dehorned. The variations in the yield of milk for the different cows are shown in the following table:

	Average daily yield for 5 days preceding operation.	Gain (+) or loss (–) on day of operation.	Gain (+) or loss (–) on day following operation.	Total gain or loss in 2 days.	Variation between largest and smallest yield in 11 days (Oct. 31–Nov. 10).
Cows dehorned:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Carrie	8.00	+0.75	—0.75	+0.00	1.75
Daisy	8.00	+0.25	—0.50	—0.25	1.00
Ida	12.25	+0.75	—0.75	+0.00	5.25
Pandora	26.50	—2.00	—6.00	—8.00	9.00
Roxy	27.25	—2.00	+0.00	—2.00	2.75
Average		—0.45	—1.60	—2.05	3.95
Cows not dehorned:					
Belva	40.00	—6.00	+2.50	—3.50	8.50
Bertha	16.25	+0.75	—1.50	—0.75	1.75
Freddie	43.00	+0.00	+0.25	+0.25	4.25
Glista	21.50	+0.00	+2.25	+2.25	3.50
Pearl	26.75	+2.50	—2.25	+0.25	5.25
Ruby	20.50	+3.50	—1.50	+2.00	5.00
Shadow	32.50	—3.50	+0.00	—3.50	12.00
Average		—0.39	—0.04	—0.43	5.75

It was found that for the 5 days following the operation as compared with the 5 days preceding, there was an average daily loss of a little less than one half a pound of milk from the five cows dehorned, while in the same period the seven cows not dehorned gave 0.7 pound per day less than in the 5 days preceding the dehorning.

A pair of patent dehorning clippers, acting on the principle of pruning shears, has been successfully used at the station.

A NEW MATERIAL FOR PRESERVING EGGS, I. P. ROBERTS, M. AGR. (pp. 376, 377).—A trial of a mineral preparation composed chiefly of silicates of iron, lime, and aluminum indicated that it was in no way superior to salt as a preservative for eggs.

THE HORN FLY, M. V. SLINGERLAND (pp. 378–381).—Compiled notes on *Hæmatobia serrata*.

SOME NEW VEGETABLES, L. H. BAILEY, M. S. (pp. 382–403, figs. 6).

Husk tomatoes (pp. 382–389).—Illustrated descriptions of *Physalis pubescens*, *P. peruviana*, and *P. capsicifolia*, which have been grown by the author. "One of these (*P. pubescens*), variously known as the Strawberry tomato, Golden Husk tomato, Dwarf Cape Gooseberry,

and Improved Ground Cherry, is well worth growing in the home garden. The true Cape Gooseberry (*P. peruviana*) is too late for this latitude. The pepper-leaved physalis (*P. capsicifolia*), erroneously known as *Physalis edulis*, is unfit for general cultivation for fruit, although it is an interesting plant to the experimenter [on account of its variability]."

Pepino (pp. 389–394).—An illustrated account of *Solanum muricatum*, which has recently been advertised as a novelty under the names of pepino, melon pear, melon shrub, and *Solanum guatamalense*. This has been grown at the station for the past 2 years. "If it could be made to set fruit more freely in the North it would be an acquisition for the kitchen garden and for market. It is a good ornamental plant. Altogether it is deserving of a wider reputation."

Chorogi (pp. 394–400).—An illustrated account of *Stachys sieboldi* [*tuberifera*], a small perennial plant of the mint family, the value of which lies in the great number of crisp white tubers of small size which it produces just under the ground. This plant has been grown at the station during 2 years. Accounts are given of the experience of various growers with it, as well as chemical analyses of the tubers from several sources. The analyses made at the station resulted as follows:

> Water 78.9, protein 12.04, ash 1.09 per cent (containing phosphoric acid 0.19, potash 0.64, and lime 0.03 per cent). All the analyses show that chorogi rates fully as high as potatoes in food and fertilizing value. * * *
>
> We have eaten the tubers prepared in several ways, and I do not hesitate to pronounce the plant the most important acquisition to our list of secondary vegetables which has been made in several years. The tubers can be cooked in a great variety of ways, or they may be eaten raw. They are fried, roasted, baked, pickled, preserved, stewed in cream, and made into various fancy dishes. The tubers may be dug as wanted during the winter, and ordinarily enough of the plant will be left in the ground to propagate it the following year. The greatest fault with the vegetable is the fact that the tubers shrivel and spoil if exposed to the air for a few hours. This will interfere with their market qualities. They can be kept in earth, however, and the French market them in moist shavings or in sawdust. Much of their value depends upon their crispness.

Spanish salsify (pp. 401–403).—An illustrated account of *Scolymus hispanicus*, "a vegetable which promises to be of considerable value in this country." It is larger and more productive than the ordinary salsify. The greatest disadvantage of the plant is its very prickly leaves.

INFLUENCE OF THE DEPTH OF TRANSPLANTING UPON THE HEADING OF CABBAGES, L. H. BAILEY, M. S. (pp. 403–405).—Summaries are given of experiments in 1889 and 1890, reported in Bulletins Nos. 15 and 25 of the Station (see Experiment Station Record, vol. I, p. 283, and vol. II, p. 508). In 1891 deep and shallow planting were compared for Early Wakefield and Premium Drumhead cabbages. The results do not indicate that depth of planting exerts any decided influence on the extent or weight of the crop.

VERBENA MILDEW, L. H. BAILEY, M. S. (p. 405).—Sulphide of potassium (one fourth of an ounce to 1 gallon of water) has been found to be an effective remedy for *Oidium erysiphioides* on greenhouse plants.

North Dakota Station, Bulletin No. 3, October, 1891 (pp. 14).

DISEASES OF SHEEP, T. D. HINEBAUCH, V. S.—Popular notes on the symptoms and treatment of anthrax, contagious and sporadic foot rot, head and common scab, inflammation of the lungs, and pleurisy.

North Dakota Station, Bulletin No. 4, December, 1891 (pp. 31).

POTATO SCAB, NATURE AND TREATMENT, H. L. BOLLEY, M. S. (pp. 3-17 and 21-31, plates 2, figs. 4).—The nature of this disease is discussed with special reference to the investigations of the author reported in the Proceedings of the American Association for the Advancement of Science, August, 1890, and in *Agricultural Science*, vol. IV, Nos. 9 and 10, and those of R. Thaxter, reported in bulletin No. 105 and in the Annual Report of the Connecticut State Station for 1890 (see Experiment Station Record, vol. II, p. 490, and vol. III, p. 9). Additional observations by the author showing that the fungus discovered by Thaxter is the cause of the scab, are cited, with illustrations. The author is still inclined to doubt the existence of "deep" and "surface" scab as distinct diseases. Microscopic examinations and culture tests have indicated that potato scab is common on beets. Swedish turnips, carrots, and cabbage roots are also apparently affected by the same disease. Experiments in planting potatoes in various kinds of soil and under different conditions have indicated that (1) scabby seed potatoes will induce the disease in the new crop upon any kind of soil, and (2) the disease germs will remain from year to year in ground where potatoes have grown. Notes and tabulated data are given for laboratory and field experiments with the following preventive treatments of seed tubers: (1) Brushing and washing clean with water; (2) soaking in solutions of corrosive sublimate (0.001 to 0.003 per cent), potassium sulphide (0.5 per cent), potassium hydrate (0.5 per cent), hydrochloric acid (3 per cent), copper sulphate, or hot water (55° to 60° C.); (3) drying in a hot oven (45° to 80° C.); (4) rolling in sulphur; (5) exposing to sulphur fumes (2.5 hours). The results indicate that brushing and washing tubers selected with reference to their freedom from scab, will insure a healthy crop on uninfected land, and that soaking in a weak solution of corrosive sublimate is an effective remedy, but hardly to be recommended on account of its poisonous nature. Potassium sulphide and hydrochloric acid have given promising results.

HASTENING THE MATURITY OF POTATOES, H. L. BOLLEY, M. S. (pp. 18-20, fig. 1).—A brief account of small experiments in which Early Rose and Charles Downing potatoes, planted after being allowed to sprout from 2 to 5 months in a light, dry room, were compared with

tubers of the same varieties planted after storage in a root cellar. Where the sprouts were 2 months old before planting the results showed an increase in yield and in earliness.

Ohio Station, Bulletin Vol. IV, No. 9 (Second Series), December, 1891 (pp. 35).

APPLE SCAB, F. DETMERS, B. S. (pp. 187-192, plates 3).—An illustrated account of *Fusicladium dendriticum*, which was very prevalent in Ohio in 1891.

THE SPRAYING OF ORCHARDS, W. J. GREEN (pp. 193-218, plates 6).—This includes an account of experiments in spraying to prevent apple scab, the plum curculio, and the "shot-hole" fungus of the plum; directions for the preparation of fungicides; and a list of manufacturers and dealers in spraying apparatus.

Spraying to prevent apple scab (pp. 193-213).—With a view to making spraying experiments on a commercial basis an orchard of about 30 acres in the vicinity of the station was leased. One third of this orchard contained Newtown Pippin apples, the other varieties being Northern Spy, Rhode Island Greening, Baldwin, Jonathan, Westfield Seeknofurther, Smith Cider, Bellflower, and Roxbury Russet. Similar experiments were carried on under the direction of the station in two other localities. About 1,000 bushels of apples were gathered from the trees included in the experiment near the station, and more than 100 bushels were assorted and counted in making up the record. In the other places the work was nearly as extensive.

In that part of the orchard containing Newtown Pippins the following mixtures were compared: Ammoniacal carbonate of copper, modified eau celeste, dilute Bordeaux mixture (copper sulphate 4 pounds, lime 4 pounds, water 50 gallons), precipitated carbonate of copper, and ammonia-copper solution. These were applied April 8, May 7 and 26, June 13 and 19, and July 16. During May and June the weather was very rainy. The relative efficiency of the different compounds is shown in the following table:

Relative efficiency of spraying compounds.

Compound used.	Apples free from scab.	Apples somewhat scabby.	Apples very scabby and unmarketable.
	Per cent.	*Per cent.*	*Per cent.*
Ammoniacal carbonate of copper	5	72	23
Modified eau celeste	12	81	7
Dilute Bordeaux mixture	15	74	11
Precipitated carbonate of copper	14	54	32
Ammonia-copper solution	1	50	49
Unsprayed		40	60

Calculations of material and labor are given which indicate that the dilute Bordeaux mixture is the cheapest of the compounds used, whether applied alone or in combination with Paris green or London purple.

The effect of the scab on the size of apples is shown from the fact that a bushel of Newtown Pippins which were free from scab contained 202 apples, while 317 scabby apples were put into the same measure. The average weight per apple was 4 and 2.5 ounces, respectively.

With respect to the effect of spraying on different varieties, calculations are given which may be summarized in the following table:

Gain from spraying with dilute Bordeaux mixture.

Variety.	In number of apples.	In size of apples.	In number of marketable apples.	In value per 100 bushels.
	Per cent.	*Per cent.*	*Per cent.*	
Benoni	81	20	31	$28.10
Northern Spy	49	23	12	24.05
Newtown Pippin	15	10	49	26.11
Rome Beauty	92	36	19	33.74

The brief accounts of similar experiments in Lawrence County, Ohio, in coöperation with the station, corroborate those of the experiments above described. Similar experiments to prevent pear scab are briefly reported, in which the dilute Bordeaux mixture and modified eau celeste were about equally beneficial, but the latter injured the foliage to some extent.

Spraying for the plum curculio (pp. 213–216).—Reports from a number of fruit growers in Ohio are given, indicating that spraying with Paris green is considered an effective remedy for the plum curculio. The need of caution in the preparation of the mixture in order to prevent injury to the foliage, is urged. It is thought that 2 ounces of Paris green to 50 gallons of water is sufficient, if three or four applications are made during the season, and that the use of the dilute Bordeaux mixture in connection with the insecticide will prevent injury to the foliage. This mixture of fungicide and insecticide was also used with beneficial effects on pear trees affected by the curculio.

Spraying for "shot-hole" fungus of the plum (pp. 216, 217).—*Septoria cerasina* was prevalent in plum orchards in 1891, causing the premature dropping of the leaves. Paris green alone aggravated the trouble, but in connection with the dilute Bordeaux mixture it was quite effective in preventing the disease. The author advises the use of the combination two or three times during the season, after which Paris green should be applied alone once or twice.

Oklahoma Station, Bulletin No. 1, December, 1891 (pp. 14).

GENERAL INFORMATION, HISTORY, AND ORGANIZATION, J. C. NEAL, M. D., AND A. C. MAGRUDER, B. S.—This includes the text of the acts of Congress of March 2, 1887, and of the legislature of the Territory of October 27 and December 25, 1890, under which the station was established. The station is made a department of the Agricultural and Mechanical College of the Territory of Oklahoma and is under the direction of the board of regents of the college, consisting of the governor

of the Territory *ex officio* and five other members. Two hundred acres of land offered by the citizens of Stillwater, Payne County, was accepted as the site of the college and station. The board of regents was organized June 25, 1891, by the election of R. J. Barker as president and A. A. Ewing as treasurer. August 14, 1891, J. C. Neal, botanist and entomologist of the Florida Station, was elected director, and November 25, 1891, A. C. Magruder, formerly of the West Virginia Station, was elected agriculturist and horticulturist. December 2, 1891, plowing the land for the experiment orchard began. Of the 160 acres which constitute the station farm, 120 acres was unbroken prairie in the fall of 1891, the remaining 40 acres being "1.5 years from the sod." The erection of suitable buildings will be at once begun and the station will undertake such experiments as are required by the agricultural needs of a new community. Since the soil and climate of the Territory seem to be adapted to fruit growing, tests will be made of varieties of orchard and small fruits. Forest and nut trees will be planted and questions relating to the reforestation of the vast treeless plains of the Territory will be investigated. The growing of sorghum for sugar promises to be a matter of much importance to this section. Methods of reducing prairie sod to arable land will be studied in connection with experiments to find out what crops are best adapted to the region.

Oregon Station, Bulletin No. 15, January, 1892 (pp. 16).

TESTS OF VEGETABLES, G. COOTE.—*Tomatoes.*—Notes and tabulated data are given for 55 varieties of tomatoes tested with reference to earliness. The earliest varieties were Livingston Perfection, Early King Humbert, Livingston Beauty, Cardinal, Livingston Favorite, Alpha, and Large Round Yellow. Plants pruned after the fruit had set yielded large and superior fruit. Training on trellises was not profitable. Tobacco stems placed in the soil near young tomato plants prevented injury by cutworms.

Cabbages.—From seed sown September 25 the first cabbage was cut June 18. The results of germination tests of 36 varieties of cabbages are tabulated. Tabulated data are also given for 27 varieties of cabbages sown in the spring.

Peas.—New Alaska and First and Best peas sown November 14 came to marketable maturity May 12 and 20 respectively. Tabulated data are given for 24 varieties sown in the spring.

Lettuce, radishes, and cauliflowers.—Notes and tabulated data on 15 varieties of lettuce, 8 of radishes, and 6 of cauliflowers.

Rhode Island Station, Bulletin No. 13, September, 1891 (pp. 14).

ANALYSES OF FERTILIZERS, H. J. WHEELER, PH. D., AND B. L. HARTWELL, B. S. (pp. 161–172).—Analyses are given of 32 samples of commercial fertilizers, including bone, and of homemade fertilizers,

limekiln ashes, wood ashes, soft phosphate from Florida, and dried refuse from the extraction of garbage with naphtha. A summary is given showing the manufacturers who sold goods within the State the past season, the number of brands analyzed, and the relation of the guaranty to the amount of nitrogen, phosphoric acid, and potash found.

Rhode Island Station, Bulletin No. 14, October, 1891 (pp. 16).

Potato scab and blight, L. F. Kinney, B. S. (pp. 175–187, figs. 3).—The nature of potato scab is discussed in brief compiled notes. An experiment with reference to the conditions favorable to potato scab was made on 5 plats, each 30 by 33 feet. Five varieties of potatoes were planted over and under stable manure or seaweed and without any fertilizers. From the tabulated results the following average percentages of merchantable tubers affected by the scab are taken: No fertilizer 13.7, on manure 26.4, under manure 44.5, on seaweed 13.2, under seaweed 10.4. An experiment in the use of Bordeaux mixture for potato scab, described in notes and tables, is summarized as follows:

Method of planting.	No Bordeaux mixture.	Vines sprayed.	Seed sprayed.
	Per cent.	*Per cent.*	*Per cent.*
On stable manure lightly covered with earth	23.5	22.6	11.2
On stable manure	37.7	30.8	10.5
Under stable manure	43.8	24.7	8.7
Average	35.0	26.0	10.1

Where potato vines were treated with Bordeaux mixture three times during the season to prevent the rot the average yield was 177 bushels per acre as compared with 124 bushels from plants not sprayed.

Transplanting onions, L. F. Kinney, B. S. (pp. 188–190, fig. 1).—Reference is made to previous experiments by T. Greiner and W. J. Green. The results obtained by the latter were reported in Bulletin vol. III, No. 9 (second series) of the Ohio Station (see Experiment Station Record, vol. II, p. 605). In a small experiment at the Rhode Island Station in 1891, Weathersfield Red, Yellow Danvers, and White Portugal onions sown February 20 and transplanted May 1, were compared with those of the same varieties sown in the field April 15. "The yield of first-class marketable bulbs was somewhat larger in the transplanted rows."

South Dakota Station, Fourth Annual Report, 1891 (pp. 14).

Report of Director, L. McLouth, Ph. D. (pp. 193–203).—This is for the fiscal year ending June 30, 1891, and includes brief descriptions of the buildings and equipment of the station, general statements regarding the work pursued during the year, and abstracts of the

bulletins issued. Investigations in dairying have been commenced, and a dairy house and barn have been erected. An insectary and a veterinary laboratory have also been built. Experiments in apiculture have been undertaken.

REPORT OF TREASURER (p. 204).—This is for the fiscal year ending June 30, 1891.

Utah Station, Second Annual Report, 1891 (pp. 62).

FINANCIAL STATEMENT (p. 4).—This is for the fiscal year ending June 30, 1891.

REPORT OF DIRECTOR, J. W. SANBORN, B. S. (pp. 6–20).—Brief statements regarding the equipment of the station, an outline of the work in various lines, and abstracts of Bulletins Nos. 5–9 of the station.

REPORT ON FEEDING TRIALS, J. W. SANBORN, B. S. (pp. 20–40).

Feeding pigs (pp. 20–32).—Six lots of pigs (number not stated) were fed, from December 22 to March 2, rations composed of corn, wheat, oats, bran, wheat and roots, and bran and alfalfa, respectively, the rations for each lot remaining the same throughout the trial. The pigs were from ancestors which had been accustomed to range and they refused to eat the desired amount of grain. As a result the gains were in all cases small. The tabulated results indicate that the largest gain was made by the lot receiving corn and the next largest by the lot receiving wheat.

Alfalfa during winter in the dry state and in summer in the green state, was economically added to wheat.

Peas proved a good pork producer.

Coarse foods, as heretofore, when fed to young pigs produced slow growth. * * * Very poor pigs were fed and slow growth made, yet all of the facts indicate that pork can be successfully grown in Utah at Utah prices, and that pigs are far more profitable to feed our grain to than are cattle. It is also seen that winter feeding is successful when shelter is provided.

Feeding trials with sheep (pp. 32–40).—A trial with nine lots of three range sheep each, lasting from January 16 to April 27. The different lots received grain (wheat and oats), with hay (wild or cultivated grasses), alfalfa, cut roots, or silage. The analyses of the feeding stuffs used are given. The results, as tabulated, are favorable to the native hay and alfalfa.

REPORT OF CHEMIST, W. P. CUTTER, B. S. (pp. 40–51).—The report includes an account of the preliminary work and equipment of the laboratory, tabulated data from 6 varieties of sugar beets, analyses of two samples of soil from the college farm, and the composition and heat value of Utah fuels. The analyses of sugar beets made by the Utah Sugar Factory showed that beets containing from 14 to 19 per cent of sucrose were raised in the Territory during the past season.

Composition and heat value of Utah fuels (pp. 45–51).—With a view to determining the relative value for heating purposes of the more common fuels in the Territory, analyses were made of thirteen samples of coal, all but two of which were from mines within the Territory, and of red pine, bird's-eye pine, white cedar, red cedar, balsam fir, maple, birch, quaking asp, mahogany, wild cherry, and hawthorn, and the number of Calories liberated in the burning of 1 gr. of these materials was determined. These results are tabulated and an explanation is given of the methods of determining heat values.

(1) The major part of coal sold in Utah is bituminous and of good quality.

(2) The anthracite coal from Colorado, on account of its large content of ash, is not of much greater theoretical value than the bituminous coals.

(3) The wood of the Territory is principally derived from mountain forests and is "soft wood." The methods of selling wood by the cubic cord make the purchase something of a lottery.

(4) From the data at hand, we conclude that 1 cord of pine wood is of as great heating value as 1 ton of bituminous coal, and it is probably somewhat greater. Further investigation may slightly modify this conclusion.

Report of Horticulturist, E. S. Richman, B. S. (pp. 51–59).—This includes a list of the experiments in progress, and brief descriptive notes on tests of 45 varieties of cabbages and 16 of cauliflowers. Landreth Earliest, Henderson Succession, Maule Midsummer, Maule Prize Flat Dutch, Improved Brunswick, and Premium Large Flat Dutch were the most promising varieties of cabbages. Early Snowball, Imperial, Landreth First, and Maule Prize Earliest proved to be the most desirable varieties of cauliflowers.

Report of Superintendent of Farm, A. A. Mills, B. S. (pp. 59–62).—Short accounts are given of tests of varieties of wheat, oats, barley, corn, forage plants, root crops, and grasses.

Meteorological observations, J. H. Walker.—Tabulated daily records of observations from March to December, 1891, inclusive, together with soil temperatures at depths of from 1 to 24 inches.

Virginia Station, Bulletin No. 11, October, 1891 (pp. 31).

Tests of vegetables, W. B. Alwood (figs. 3).—This includes accounts of tests of varieties of tomatoes, potatoes, onions, cabbages, and cauliflowers, which have been carried on at the station during the past 3 years.

Tomatoes (pp. 3–14).—Tabulated data and descriptive notes are given for 10 early and 13 late varieties. Earliness has been especially considered and the tests have indicated that the fact that one variety ripens a few fruits 10 or even 20 days before another sort, is of little practical consequence, as is shown in the following tables:

Results of tests of varieties of tomatoes.

Variety.	Source of seed.	First ripe.	Yield August 1–15.		Yield after August 15.		Total yield.		Average yield per plant.		Last ripe.
			Lbs.	*oz.*	*Lbs.*	*oz.*	*Lbs.*	*oz.*	*Lbs.*	*oz.*	
Early:											
Acme	Livingston	July 28	7	4	32	13½	40	3	13	6⅓	Sept. 2
Dwarf Champion	Harris	July 20	4	6½	26	9	31	5	10	7	Sept. 2
Gem (Hallock New)	Hallock	July 24	5	0	27	3	32	8	10	13⅓	Sept. 2
Goldsmith	Livingston	July 22	1	13	29	9	31	6	10	8	Sept. 2
Haines No. 64	Station	July 30	4	2½	38	4	43	2	14	6	Sept. 2
Perfection	Do	July 30	3	9	35	12½	39	10	13	3⅓	Sept. 2
Prelude	Thorburn	July 22	6	0	33	1½	39	12	13	4	Aug. 27
Early Ruby	Henderson	July 14	11	0½	17	10½	31	6	10	7⅓	Aug. 27
Golden Sunrise	Station	July 30	4	9	32	13½	37	9	12	8⅓	Sept. 2
Table Queen	Henderson	July 30	7		61	3	68	12	23	⅔	Aug. 27
Late:											
Beauty	Station	Aug. 6	8	11½	37	2½	45	14	15	4⅔	Sept. 2
Favorite	Tait	Aug. 14	2	4½	31	11½	34	0	11	5⅓	Sept. 2
Ignotum	Station	Aug. 3	8	7	28	10	37	1	12	5⅔	Aug. 27
Long Keeper	Thorburn	Aug. 3	8	2	30	0	38	2	11	11⅓	Sept. 2
McCullom Hybrid	Vick	Aug. 3	3	5	44	7	47	12	15	14⅔	Sept. 2
Mikado	Station	Aug. 10	8	11	31	11	40	6	13	5⅓	Sept. 2
Paragon	Do	Aug. 14	1	12	41	6	43	2	14	6	Sept. 2
Potomac	Harris	Aug. 14	2	0	38	5	40	5	13	7	Sept. 2
Primate	Thorburn	Aug. 6	3	11½	30	9½	34	5	11	7	Sept. 2
Red Cross	Hallock	Aug. 10	8	0½	47	0½	55	1	18	5⅔	Sept. 2
Stone	Livingston	Aug. 10	1	8½	26	7½	28	0	9	5⅓	Sept. 2
Triumph	Hallock	Aug. 10	2	9½	35	6½	38	0	12	10⅔	Sept. 2
"400"	Henderson	Aug. 8	12	0	41	13	53	13	17	5	Sept. 2

The method of transplanting tomatoes described in Bulletin No. 9 of the station (see Experiment Station Record, vol. II, p. 670) was tried again in 1891 with some 25,000 plants, with decidedly favorable results. The transplanting was done in cold frames instead of in the field, as in the previous season.

The experience of the station in the use of fertilizers for tomatoes indicates that they were "injuriously affected by the application of nitrate of soda alone and are not benefited by the use of potash or phosphoric acid singly," but that all three together applied shortly after transplanting to the field materially increased the yield and improved the quality of the fruit.

Potatoes (pp. 15–18).—A list is given of 127 varieties tested in 1891. Previous reports of similar tests may be found in Bulletins Nos. 6 and 8 of the station (see Experiment Station Record, vol. II, pp. 133 and 669). The following tabulated summaries for 19 varieties grown during the past 3 years are taken from the bulletin:

Results of tests of varieties of potatoes.

Variety.	Estimated yield per acre, 1891.	Average estimated yield per acre for 3 years.	Date of ripening, 1891.	Condition in cellar March 6, 1891.
	Bushels.	*Bushels.*		
Early:				
Charles Downing	171.5	237.2	Aug. 4	Firm.
Corona (Corona Beauty)	132.0	192.0	Aug. 8	Do.
Early Ohio	144.1	145.0	Aug. 4	Do.
Early Rose	240.0	189.6	Aug. 4	Do.
Early Hebron	261.8	148.3	Aug. 12	Fairly firm.
Early Electric	163.4	193.4	Aug. 4	Do.
Early Essex	165.2	251.7	Aug. 4	Do.
June Eating (Crane June Eating)	215.4	254.5	Aug. 8	Do.
Sunrise	150.1	195.4	Aug. 12	Solid.
Medium early:				
Beauty (Rose Beauties)	258.7	214.0	Aug. 10	Firm.
Burbank	170.8	149.7	Aug. 10	Do.
Climax	210.3	240.9	Aug. 18	Do.
Cream (Cream of the Field)	236.6	240.3	Aug. 8	Do.
Early Seneca	133.1	200.2	Aug. 12	Do.
Green Mountain	224.7	299.8	Aug. 10	Do.
La Plume	245.4	164.9	Aug. 13	Do.
Rural New Yorker No. 2	232.7	147.5	Aug. 12	Do.
Snowflake (Late Snowflake)	225.6	265.3	Aug. 12	Do.
Vermont Champion	261.3	201.7	Aug. 12	Do.

Onions (pp. 19–23).—A list of 40 varieties tested at the station during the past 3 years is given. The following are especially commended: White Barletta, Large Flat White Italian, White Globe, South Port White Globe, Red Bermuda, Yellow Danvers, Red Wethersfield, Giant Rocca, and Prize Taker. General directions are given for the culture of onions. The method of transplanting onion sets grown from seed in a forcing house or hotbeds has been tried at the station with favorable results. Reference is made to experiments in this line by T. Greiner and W. J. Green. The latter has published an account of his work in Bulletin vol. III, No. 9 of the Ohio Station (see Experiment Station Record, vol. II, p. 605).

Cabbages (pp. 24–29).—Tabulated data and descriptive notes are given for 15 varieties grown in 1891, together with a list of 20 other varieties tested. The following are especially commended: Early Wakefield, Newark Early Flat Dutch, Nonesuch, Strang, and Louisville Extra Drumhead.

Cauliflowers (pp. 30, 31).—A list of 30 varieties tested at the station. Early Dwarf Erfurt, Snowball, Ideal, and Carrara Rock are especially commended.

Washington Station, Bulletin No. 1, December, 1891 (pp. 15).

HISTORY AND ORGANIZATION, G. LILLEY, PH. D.—This includes extracts from the act of the State legislature of March 9, 1891, establishing the Agricultural College, Experiment Station, and School of Science of the State of Washington, and from the acts of Congress of March 2, 1887, and August 30, 1890, and general statements regarding the history, organization, equipment, and plans of work of the college

and station. The institution is located at Pullman, Whitman County, in a region possessing unusual agricultural resources. The climate is comparatively mild. The annual precipitation averages about 40 inches.

The college and the station own a tract of 220 acres of very choice and valuable land, consisting of valley, sidehill, and table-land. The farm is about 1 mile east of the business part of the town. It is remarkably well adapted for horticultural, fruit, and forestry experiments; for grazing and hay; for the culture of the various cereal grains and other farm products; for lawns; and for parks and campus.

The soil is of great depth and is inexhaustible, and contains those salts and silicates so essential to plant life. It is a sedimentary deposit, evidently of volcanic origin, as it is composed of a sandy loam, disintegrated basalt, and ash. It is very porous and readily drinks in moisture and gives it out as needed, allowing the salts to rise to feed the crops. The farm is inclosed and the greater part of it is now under cultivation. During the past year it produced good crops, consisting of wheat, oats, barley, and rye. A one-story brick building, 60 by 36 feet, has been completed, at a cost of about $2,500, which will be used temporarily for class purposes.

The college and station are under the control of a board of managers consisting of five members, together with the governor of the State as advisory member and the director of the station as secretary. The station staff at present includes G. Lilley, LL. D., director; J. O'B. Scobey, M. A., agriculturist; E. R. Lake, M. S., horticulturist and botanist; G. G. Hitchcock, B. A., chemist, and C. E. Munn, V. S., veterinarian. Among the lines of work which will be undertaken the coming season are the study and collection of the flora of the State; tests of grasses, forage plants, and fruits with reference to their adaptability to this region; and investigations in forestry. It is expected that much preliminary study, of the nature of an agricultural survey, will be needed to find out what are the lines of work which will be of greatest service to this new commonwealth.

West Virginia Station, Bulletin No. 18, September, 1891 (pp. 16).

INSPECTION OF FERTILIZERS, J. A. MYERS, PH. D. (pp. 103–118).—This includes the text of the West Virginia fertilizer law, directions for taking samples of fertilizers for analysis, instructions to manufacturers and general agents, the trade values of fertilizing ingredients for 1891, and analyses of 84 samples of commercial fertilizers. From the results of the fall inspection the author concludes that "27 per cent of the commercial fertilizers sold in West Virginia fall below the manufacturers' guaranty."

New fertilizer law (pp. 103–106).—This was passed March 6, 1891. It requires all fertilizers to be sold under guaranty of composition, and places the fertilizer control in the hands of the station. A license for the sale of fertilizers is to be procured each year, for which a fee is to be paid of $10 for each guarantied ingredient of each brand. At the time this license is procured a sample of each brand licensed is to be

deposited with the director of the station, accompanied by a statement of its guarantied composition. These samples are to be analyzed by the station, the value per ton calculated, and the results printed on tags, which are to be furnished to the sellers of the respective brands at 50 cents per hundred. The law does not make the purchase or use of these tags compulsory. The station may also collect from dealers samples of commercial fertilizers for analysis and publish the results in bulletins. The penalty for noncompliance with the provisions of the law is a fine of from $50 to $500.

West Virginia Station, Bulletin No. 19, November, 1891 (pp. 9).

WEEDS AS FERTILIZERS, C. F. MILLSPAUGH, M. D. (pp. 121–127).—Calculations of the fertilizing value of the following species of weeds, from analyses by R. DeRoode, Ph. D., with suggestions for their use in composts: Polk weed (*Phytolacca decandra*), bitter dock (*Rumex obtusifolius*), common thistle (*Cnicus lanceolatus*), crowfoot grass (*Panicum sanguinale*), sheep sorrel (*Oxalis corniculata*, var. *stricta*), foxtail grass (*Setaria glauca*), pleurisy weed (*Asclepias tuberosa*), Bokhara clover (*Melilotus alba*), burdock (*Arctium lappa*), ox-eye daisy (*Chrysanthemum Leucanthemum*), wild lettuce (*Lactuca canadensis*), wild carrot (*Daucus carota*), butterweed (*Lactuca leucophæa*), deer-tongue grass (*Panicum clandestinum*), blue thistle (*Echium vulgare*), ironweed (*Vernonia noveboracensis*), clotbur (*Xanthium strumarium*), climbing buckwheat (*Polygonum dumetorum*, var. *scandens*), yarrow (*Achillea millefolium*), toadflax (*Linaria vulgaris*), Indian tobacco (*Lobelia inflata*), stickweed (*Aster lateriflorus*), briars (*Rubus villosus*), wing stem (*Actinomeris alternifolia*), velvet grass (*Holcus lanatus*), boneset (*Eupatorium perfoliatum*), timothy (*Phleum pratense*), milk weed (*Asclepias syriaca*), blue devil (*Aster cordifolius*, var. *lævigatus*), wild coreopsis (*Coreopsis tripteris*), nail rod (*Aster lateriflorus*, var. *hirsuticaulis*), wire grass (*Eatonia pennsylvanica*), redtop (*Agrostis alba*, var. *vulgaris*), quill weed (*Eupatorium purpureum*), Canada thistle (*Cnicus arvensis*), sorrel (*Rumex acetosella*), rheumatism weed (*Apocynum androsæmifolium*), elder (*Sambucus canadensis*), ragweed (*Ambrosia artemisiæfolia*), golden-rod (*Solidago juncea*), Spanish needles (*Bidens frondosa*), orchard grass (*Dactylis glomerata*), naked weed (*Chondrilla juncea*), oat grass (*Danthonia spicata*), old-field balsam (*Gnaphalium obtusifolium*), evening primrose (*Œnothera fruticosa*), blue joint (*Andropogon provincialis*), broom sedge (*Andropogon scoparius*), panicled panic grass (*Panicum virgatum*).

Wyoming Station, First Annual Report, 1891 (pp. 40).

This includes general statements regarding the work and equipment of the station in its several departments, and of the experiment farms at Lander, Laramie, Saratoga, Sheridan, Sundance, and Wheatland. There is also a financial statement for the fiscal year ending June 30, 1891.

Wyoming Station, Bulletin No. 4, December, 1891 (pp. 30).

METEOROLOGY FOR 1891, B. C. BUFFUM, B. S. (pp. 67–94, figs. 7).—Brief illustrated descriptions of the apparatus used in taking observations and tabulated records of 6 months' (July–December) observations at the station, with records of temperature and precipitation for the first half of the year, furnished by an officer of the U. S. Weather Bureau. The general summary is as follows: *Pressure* (inches).—Mean (September–December) 22.97. *Air temperature* (degrees F.).—Maximum 82.5, August 13; minimum –13, December 7; mean 40.9; maximum daily range, July–December, 50.9 (August 7); minimum daily range, July–December, 4.2 (December 28); mean daily range, July–December, 26.4. *Humidity* (July–December).—Mean relative humidity 66.4, mean dew-point 30.1. *Precipitation* (inches).—Total 13.92, maximum monthly 2.92 (May), minimum monthly 0.30 (October). *Weather.*—Light frost July 13; injurious frost August 22. *Wind* (miles).—Total movement, July–December, 56,940.4; maximum velocity 65 (November 10); mean daily movement 311.2; mean hourly movement 12.9. *Soil temperatures* (degrees F.).—Mean (July 5–January 2) at depth of 3 inches 44.6, 6 inches 48.5, 12 inches 49.8, 24 inches 50.4, 36 inches 48.6, 72 inches 51.7.

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN NO. 6.

TOBACCO, CULTIVATION AND CURING, J. M. ESTES (pp. 8).—Brief instructions for the management of tobacco by farmers.

DIVISION OF VEGETABLE PATHOLOGY.

FARMERS' BULLETIN NO. 5.

TREATMENT OF SMUTS OF OATS AND WHEAT, W. T. SWINGLE (pp. 8, plate 1).—This popular bulletin includes brief illustrated descriptions of the loose smut of oats (*Ustilago avenæ*) and the stinking smuts of wheat (*Tilletia fœtens* and *T. tritici*); statements regarding amount of damage caused by smut; directions for treatment with hot water, potassium sulphide, or copper sulphate; and a list of publications on this subject.

DIVISION OF BOTANY.

CONTRIBUTIONS FROM THE U. S. NATIONAL HERBARIUM, VOL. III, NO. 1, FEBRUARY 25, 1892.

MONOGRAPH OF THE GRASSES OF THE UNITED STATES AND BRITISH AMERICA, G. VASEY (pp. 89).—This number includes classified descriptions of about half of the 800 species of grasses found in the United States and British America.

OFFICE OF EXPERIMENT STATIONS.

EXPERIMENT STATION BULLETIN NO. 10.

METEOROLOGICAL WORK FOR AGRICULTURAL INSTITUTIONS, M. W. HARRINGTON (pp. 23).—This contains suggestions of lines of meteorological work appropriate to agricultural colleges and experiment stations, together with statements regarding the necessary outfit. For a further account of this bulletin see p. 585 of this number of the Record.

DIVISION OF STATISTICS.

REPORT NO. 92 (NEW SERIES), JANUARY AND FEBRUARY, 1892 (pp. 44).—This includes articles on the number and value of farm animals; cotton crop; European crop report; notes on foreign agriculture; new railway construction, 1891; and rates of transportation companies.

The following summaries of the number and value of farm animals in the United States, as estimated for January 1, 1891 and 1892, are taken from the bulletin:

Number and value of farm animals.

Stock.	Number.			Value.		
	1891.	1892.	Increase or decrease.	1891.	1892.	Increase or decrease.
Horses	14,056,750	15,498,140	+1,441,390	$941,823,222	$1,007,593,836	+$65,770,414
Mules	2,296,532	2,314,699	+ 18,167	178,847,370	174,882,070	— 3,965,300
Milch cows	16,019,591	16,416,351	+ 396,760	346,397,900	351,378,132	+ 4,980,232
Oxen and other cattle	36,875,648	37,651,239	+ 775,591	544,127,908	570,749,155	+ 26,621,247
Sheep	43,431,136	44,938,365	+1,507,229	108,397,447	116,121,270	+ 7,723,823
Swine	50,625,106	52,398,019	+1,772,913	210,193,923	241,031,415	+ 30,837,492
Total	163,304,763	169,216,813	+5,912,050	2,329,787,770	2,461,755,678	+131,967,908

DIVISION OF CHEMISTRY.

BULLETIN NO. 31.

PROCEEDINGS OF THE EIGHTH ANNUAL CONVENTION OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS (pp. 253, figs. 8).—These are for the meeting of the Association held at Washington, D. C., August 13, 14, and 15, 1891, and are edited by H. W. Wiley, secretary of the Association. Reports on methods and results of analyses are given on the following subjects: Fermented liquors, by W. B. Rising; dairy products, by W. W. Cooke; feeding stuffs low in carbohydrates, by C. D. Woods; cattle foods rich in carbohydrates, by A. E. Knorr; nitrogen, by W. Frear; phosphoric acid, by H. A. Huston; potash, by H. B. Battle; soils, by R. C. Kedzie; and sugar, by W. C. Stubbs. In most casest hese reports contain brief abstracts of the literature of the different subjects for the time covered by the report. There are also included the official methods adopted by the Association for the analysis of fertilizers, feeding stuffs, dairy products, fermented liquors, and sugar, and elective methods; reports of the committees on the formation of a national chemical society, on a chemical exhibit at the World's Columbian Exposition, and on atomic weights; the method of the U. S. Internal Revenue Office for the analysis of sugars; the table of revised atomic weights adopted by the Association; and the following papers: A Brief Review of the History and Present Condition of Efforts for the Establishment of Uniformity in Methods of Technical Chemical

Analysis, by G. C. Caldwell; Analysis of Sour Milk, by W. W. Cooke; Composite Milk Samples in the Laboratory, by G. E. Patrick; Estimation of Fats in Foods by Direct Weighing and by Loss of Weight of the Substance, by H. Snyder; An Error in the Present "Official Method" for the Determination of Albuminoid Nitrogen, and the Effect of the Presence of Metals that are Precipitable by Potassium Sulphide in the Determination of Nitrogen by the Kjeldahl Method, by H. Snyder; Meat Analysis, Testing of Apparatus and Method, by P. Schweitzer, and C. P. Fox; True Ash in Products of Cane-Sugar Manufactories, Incinerated with Sulphuric Acid, by L. Biard; The Determination of Phosphoric Acid and Nitrogen in Commercial Fertilizers in the same Weighed Quantity of Substance, by R. De Roode; Insoluble Phosphoric Acid, by F. W. Morse; Proposed Method for the Analysis of Native Phosphates Containing Iron and Aluminium, by L. W. Wilkinson; Proposed Changes in the Association Method for the Determination of "Water Soluble" and "Acid" or "Insoluble" Phosphoric Acid, and the Adoption by the Association of a Method for the Analysis of Native Phosphates Containing Iron and Aluminium, by L. W. Wilkinson; The Determination of Total Phosphoric Acid in Fertilizers Containing Organic Materials, by F. W. Shiver; A New Distilling Flask for Use in the Kjeldahl Process, by G. E. Patrick; On the Use of Sodium Chloride in the Lindo-Gladding Method of Determining Potash, by A. L. Winton, jr.; Sources of Error in the Determination of Potash, by B. Terne; Loss of Moisture in Bottled Fertilizer Samples when Closed with Cork, by H. B. Battle; and The Effect of Finer Grinding in the Preparation of Fertilizer Samples, by H. B. Battle.

acid and a yellow substance. The action was slower than in the former case, owing probably to the commencement of the oxidation while the material was being prepared under the influence of the air and the potash.

These observations indicate that the brown substances of humus and their analogues undergo direct oxidation under the influence of the air and sunlight, forming carbonic acid and changing their color. These reactions are purely chemical, taking place without the influence of microbes. This oxidation of humus is rendered more active by the division and mellowing of the humus materials as the result of the cultivation of the soil. While in this way the humus appears to be made more assimilable by plants the same processes hasten the destruction of the organic substances in arable soil, either under the influence of vegetation, or by the help of microbes, or by purely chemical means when the soil is exposed to the light. The bare surfaces of the soil give off carbonic acid and form soluble compounds, which are carried away by the meteoric waters. Thus the humus materials of the soil need constant renewal as well by the decomposition of dead plants as by the addition of fertilizers.

Effects of different proportions of clay and of organic nitrogen on the fixation of atmospheric nitrogen, the conservation of nitrogen, and nitrification, P. Pichard (*Compt. rend., 114 (1892), pp. 81-84*).—Mixtures of pure silicious sand and clay which showed no traces of nitrogen at the beginning of the experiment contained noticeable quantities after 7 months—0.07 gr. in a kg. of soil containing 10 per cent of clay, 0.12 gr. in soil with 20 per cent of clay, 0.20 gr. in soil with 30 per cent of clay. The amounts of nitrogen fixed were nearly proportional to the amounts of clay. Small quantities of nitric and ammoniacal nitrogen were also found in these soils. These observations agree with previous ones by Berthelot and others, including the author.

The addition of plaster slightly increased the proportion of nitrogen fixed, as well as of nitric acid and ammoniacal nitrogen. The favorable influence of clay and of plaster was also seen in mixtures of clay, sand, and cotton oil cake. The influence of clay on the conservation of the nitrogen and the fixation of atmospheric nitrogen was clearly seen in "complete" soils, containing sand, clay, oil cake, plaster, and lime. In soils containing approximately 2 and 3 gr. of organic nitrogen per kg. the effect of the clay on the conservation of the nitrogen was still seen but did not directly manifest itself in the fixation of atmospheric nitrogen. In these soils there was no gain of nitrogen.

The proportion of clay within the limits of from 10 to 40 per cent did not clearly affect the nitrification. Increasing the quantity of organic nitrogen from 1 to 3 gr. per kg. of soil was clearly unfavorable to nitrification. Not only the relative proportions, but also the absolute quantities of nitric nitrogen decreased as the amount of organic nitrogen

increased. The proportion of ammoniacal nitrogen, however, was not appreciably increased in the soils containing 2 or 3 gr. of organic nitrogen as compared with those containing only 1 gr. per kg., and consequently the absolute amount of ammonia produced was larger in the former soils.

The following practical conclusions are drawn from these experiments:

(1) If it is desired in the preparation of composts to transform nitrogenous organic matter into nitrate, the mixture should not contain over 1 gr. of nitrogen per kg. Thirty per cent of clay or marl and 0.5 per cent of plaster may be added. The compost will then be in a favorable condition to fix atmospheric nitrogen.

(2) If the production of ammoniacal nitrogen is desired, the amount of organic nitrogen per kg. of compost may be increased to 2 or 3 gr. or even more. From 10 to 40 per cent of marl and 0.5 to 1 per cent of plaster may be added.

(3) In soils where there is no danger of arresting nitrification by the formation of a medium which is too ammoniacal it will be useful to increase the amount of lime or to use unslaked lime in combination with plaster.

Recent observations on the amount of sulphur in arable soil and on the nature of the compounds which it forms, Berthelot and André (*Compt. rend., 114 (1892), pp. 43–46*).—In connection with researches regarding the formation of sulphur compounds in plants (see *Annales de Chimie*, sér. 6, tom. XV, p. 124) the authors made some observations on sulphur in arable soil. The soil in which the plants were grown contained per kg. of dry earth 0.372 gr. of sulphur (total) and 0.169 gr. of sulphate. Treatment with a potash solution (boiling) gave 0.357 gr. of sulphur in the soluble portion and 0.023 gr. in the insoluble portion. The total sulphur, 0.38 gr., did not materially differ in amount from that given above. The potash solution did not entirely decompose the sulphate in the soil, for the liquid filtrated after this reaction contained 0.114 gr. of sulphate (after potash without heat) and 0.139 gr. (after potash with heat), whereas the total sulphate was 0.169 gr.

The organic sulphur in this soil was 0.372–0.169=0.203 gr.; the organic nitrogen 2.356 gr. In another soil containing 1.17 gr. of total sulphur the organic sulphur was 0.61 gr. and the nitrogen 1.67 gr. In the former case, therefore, the percentage of organic sulphur as compared with nitrogen was 8.7; in the latter 36.5. The latter soil also contained 19.1 gr. of organic carbon. In animal albuminoids (albumin and fibrin for example) the percentage of sulphur is 10 to 11, while in horny substances it is about 20. In animal organisms in general, as analyzed by Bidder and Schmidt, the percentage was about 7.

But this mode of comparison is not sufficiently wide. In arable soil, generally speaking, the relation between organic carbon and nitrogen by weight is entirely different from that in albuminoids and animal

The higher digestibility of the ether extract of the silage, as compared with that of the grass from which it was made (60.94 *vs.* 45.65 per cent), is likewise attributed to the volatile organic acids in the silage.

Besides the increase in digestibility of the ether extract and the wide decrease in the digestibility of the crude protein by ensiling, the results show that the crude cellulose increased and the nitrogen-free extract diminished in digestibility. This latter fact is in accord with the changes occurring in making brown or "burnt" hay (*Brennheu*); for Weiske* found, in experiments with sheep, that the digestibility of crude cellulose in burnt hay made from alfalfa was 44.6 per cent as compared with 34.2 per cent in carefully dried alfalfa hay, while that of the nitrogen-free extract diminished from 65.3 in the dried hay to 54 in the burnt hay.

A calculation of the percentage losses of crude and digestible ingredients in grass by ensiling, based on the coefficients found and on the observed loss of total dry matter by molding, etc., gives the following results:

Percentage loss of food ingredients by ensiling.

	Dry matter.	Ash.	Organic matter.	Crude protein.	Crude fat.	Crude cellulose.	Nitrogen-free extract.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Loss of crude ingredients....	42.67	30.77	44.09	35.54	27.07	45.21	46.76
Loss of digestible ingredients.	47.76	28.57	49.08	68.63	2.35	36.88	53.93

The exact effect of feeding the silage could not be definitely determined, but the indications were that it was less, pound for pound of organic matter, than that of the original grass. Thus in the present case there was a loss by ensiling not only in total amount of organic matter, but also in its digestibility and (probably) feeding value.

Feeding value of wet vs. dry diffusion residue of sugar beets, M. Maercker and A. Morgen.—The diffusion method for extracting sugar from beets as practiced in Germany is a great improvement upon the older process of expressing the juice. It has, however, the disadvantage for the farmer that the residue is very watery and less valuable for feeding than the pressed residue.

The farmers who grow the beets and the manufacturers who make the sugar coöperate in ways more or less analogous to those practiced in this country in the making of butter in creameries. The beets are taken to the factory and the residue is carried back to the farm and used for feeding. As it can not be fed out as rapidly as it is produced, it is stored in pits or silos, where it ferments and undergoes considerable chemical change. Although chemical analysis shows smaller proportions

* Beiträge zur Frage ü. Weidewirthschaft und Stallfütterung. Breslau, 1874.

of nutrients, calculated for percentages of dry substance, in the press residue, it is practically much more valuable for feeding than the wet diffusion residue. The explanation is found in the very watery character of the diffusion residue and in the loss it suffers in keeping.

The effort to remove the water from diffusion residue by pressing has proved unavailing. The only help seemed to be in drying. Through the efforts of Maercker and others, the Association of German Beet Sugar Manufacturers (*Verein der deutscher Rübenzuckerfabrikanten*) was induced to take the matter in hand and offered a prize of 10,000 marks ($2,500) for the best process for drying diffusion residue. This prize was given to Messrs. Büttner and Meyer for a drying apparatus which was invented by them and which proved very efficient. To test thoroughly the questions of the relative feeding values of the wet and dry residue, a series of investigations were undertaken by the Halle Experiment Station in coöperation with a number of beet sugar farmers and manufacturers. [These experiments were in continuation of those described in the Experiment Station Record, vol. III, p. 557.]

The investigations consisted of studies of the chemical composition and digestibility of the wet and dry residue and the changes which the former undergoes in keeping; observations of the working and the efficiency of the drying apparatus; and experiments in which the feeding values of the wet and dry residue were compared by eight trials with milch cows, fattening oxen, and fattening sheep on different farms. At the same time the results of practical experience regarding the drying of diffusion residue were collated from twelve different sugar factories. The results of the whole investigation, with the chemical and physiological considerations involved, and statements of the practical outcome and the ways in which the results may be most advantageously utilized in the drying and feeding of the diffusion residue, are clearly and concisely set forth in a volume of 168 royal octavo pages, published in August, 1891, under the title of *Wesen und Verwertung der getrockneten Diffusions-Rückstände der Zuckerfabriken*, by M. Maercker and A. Morgen. In the judgment of the authors, the results of the investigation are in every way favorable and they are already confirmed by numerous practical tests, so that the introduction of the system of drying the diffusion residue appears to be a noteworthy advance and of far more importance than was anticipated by those who coöperated in the experiments.

It is hardly probable that the results could have any such value for us in the United States in the immediate future, even if the sugar-beet industry should prove as successful as is hoped by many persons, but the investigations are nevertheless of decided interest to chemists and physiologists as well as to practical feeders, and are valuable to our stations as an illustration of a successful coöperative effort by workers in the laboratory and those in the factory and on the farm.

The subjects treated in the report are, (1) the disadvantages of storing the wet diffusion residue and of feeding the stored material; (2) the construction and operation of the drying apparatus; (3) the composition and nutritive value of the dry residue; (4) plans of feeding experiments with wet and dry diffusion residue and ways in which they were carried out by patrons of the Hadmersleben sugar factory; (5) results of feeding experiments; (6) practical experience obtained at the Hadmersleben factory and ten others regarding the drying of the diffusion residue; (7) review of practical experience regarding the drying and feeding of diffusion residue; (8) replacing of wet diffusion residue, hay, and concentrated feeding stuffs by dry diffusion residue in equivalent nutritive proportions, and mixtures of diffusion residue with other materials appropriate for different animals; (9) review of results of experiments; (10) tabular statements of composition of feeding stuffs, rations, and results of feeding experiments.

The disadvantages in storing and feeding wet diffusion residue.—These are largely such as come with the storage, handling and feeding of very wet materials in general. The principal difficulty comes from the changes in fermentation in the pits or silos in which the material is stored. The loss is estimated at one third of the whole dry substance when stored in pits and one fifth when stored in walled silos, these figures being general estimates from the results of observations made in connection with these investigations and otherwise. The diffusion residue contains in general less than 10 per cent of dry substance, its water content being about the same as that of turnips. The active fermentation and large loss of material in the pit or the silo accords with the general observation in the ensiling of green fodders, that large water content and active and injurious fermentation go together. In discussing the subject, the authors avail themselves of the results of late experimental inquiry regarding the fermentation and consequent chemical changes which take place in watery material when stored in the silo or otherwise.

Fermentation of feeding stuffs in pits and silos and its effects upon digestibility and nutritive value.—The inferences as to the effects of these changes upon the nutritive value of the diffusion residue are of interest in their bearing upon the effects of fermentation in the silo upon the composition of silage in general. The general conclusion is that the products which are formed by fermentation of diffusion residue, when stored in the pit or the silo, have a more or less diminished nutritive value as compared with the compounds in the fresh substance from which they are formed.

"According to our present knowledge of the processes of fermentation and of the nature of the products formed thereby, it may be accepted as a general principle that fermentation products are not more easily digestible nor are they in any way of higher nutritive value than the compounds from which they are formed." On the other hand, the general tendency of the fermentation is to diminish both the total quantity

and the digestibility of the substances. This is more or less true of both nitrogenous and non-nitrogenous compounds. [It is of course understood that the fermentations here referred to are in general those which are caused by bacteria and other so-called organized ferments, and which result in more or less of cleavage and kindred chemical changes, such as the formation of lactic and acetic acids from carbohydrates and of amide-like compounds from albuminoids. Such changes as those of starch into glucose and albuminoids into peptones would not be included.]

As regards the effects of the fermentations upon the digestibility of the non-nitrogenous compounds, categorical conclusions are rendered difficult by the lack of convenient and accurate methods for the determination of digestibility. "This much, however, may in general be affirmed: When a mixture of digestible and undigestible non-nitrogenous extractives is exposed to organisms which cause fermentation and putrefaction, the more easily soluble and digestible compounds are the first to be decomposed and hence are most exposed to loss. The inference is that the non-nitrogenous extractives which remain and which have been less influenced by the fermentation must contain relatively larger proportions of the undigestible constituents than would be contained in the whole of the given group of non-nitrogenous constituents in the fresh or properly dried [material]."

Another source of loss of feeding value in fermentation is the loss of potential energy. "A part of the non-nitrogenous extractives is changed into fermentation products. Here the law applies that the potential energy of the products of a fermentation which is accompanied by the evolution of heat is less than the potential energy of the original substance by the amount of heat involved. For this reason the residual products must have a lower nutritive value, and in this sense the fermentation of the feeding stuff must diminish its value."

If the fermentation is carried far enough there may not only be a loss of nutritive value from the diminution of potential energy, but the residual products may become injurious rather then nutritious, as in the formation of acetic and other acids from starch and sugar. "Unfortunately the nutritive values of the most important products of fermentation are not known with enough certainty to permit the statistical expression of this loss. It appears from the experiments of Weiske [see Experiment Station Record, vol. II, p. 681], however, that the actual nutritive value of acetic and butyric acid is very small, since addition of acetic acid to the food [of rabbits and sheep] exercised an unfavorable rather than a favorable action upon the formation of flesh [storage of protein]; more nitrogen was excreted with the acetic acid than without it. On the other hand, with lactic acid in small quantities Weiske found the nitrogen storage to be somewhat increased." It is evident then that the organic acids formed by fermentation must have far less feeding value than the carbohydrates from which they are produced, and that they may be positively detrimental.

The fresh or dry residue contained no acid to speak of, but in the fermented residue nearly 20 per cent of the whole dry substance consisted of acids of doubtful nutritive value.

As regards the protein compounds, the same principles apply. By fermentation these are converted in part into amide-like compounds, and as such, possess a certain nutritive value, though decidedly less than the albuminoids from which they are formed. Thus Julius Kühn estimates the effect of the amides in economizing protein (*als eiweiss-sparende Nährstoffe*) as equivalent only to carbohydrates.

In the fresh or dry diffusion residue practically none of the nitrogen was in the amide form, but in the fermented material on the average 8.8 per cent of the nitrogen was in this form and the amount in individual cases was much more, even as high as 24.3 per cent.

The facts at hand imply that the more soluble and easily digestible albuminoids are the first ones to be decomposed by fermentation, and that a not inconsiderable portion may be completely decomposed. It therefore seems probable that the residual protein would be less digestible than the whole protein in its original form. "So far as the digestibility of the protein of diffusion residue is concerned, the effects of fermentation have not been accurately tested previous to these investigations, but for all other feeding stuffs which have been subjected to the process (*Einsäuerung*) it has been proved that a decided diminution of digestibility of the protein takes place. Such is the outcome of the investigations from those of Gustav Kühn regarding the fermentation of bran to those of F. Albert regarding the so-called green-press fodder." As is shown by the feeding experiments made in connection with the investigations here described, the digestibility of the protein of diffusion residue is materially diminished by fermentation when stored. The following figures represent average results of tests by Stutzer's method: Coefficients of digestibility of protein in dried diffusion residue 86.7 per cent, in fermented diffusion residue 73 per cent. That the digestibility of the protein was not essentially diminished in drying by the process used, was abundantly proved.

[While the general facts are as stated there are exceptions, as appears in some of the details of the investigations here cited.* Thus in certain feeding stuffs which contain but little protein, and that in less digestible forms, it appears that the digestibility of the protein may be favored by fermentation. In how far this is due to changes in the protein compounds themselves and in how far to alterations in the chemical or mechanical characters of the other compounds or the tissues of the feeding stuffs, is by no means certain. Not only the work of the chemist, but also that of the bacteriologist and the vegetable histologist will be needed to clear up this interesting and important question.]

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* See likewise the results of observations reported by Morgen, Jour. f. Landw., 36 (1888), p. 318, and by Kellner, Kozai, and Mori, Landw. Vers. Stat., 39 (1891), p. 113, and Experiment Station Record, vol. III, p. 266.

Effect of the large quantity of water.—The large water content of the diffusion residue forces the animals to consume abnormal quantities of water. This may be disadvantageous in several ways. As the effect of water upon milk and meat production is of general interest and the discussion includes references to other inquiries, the considerations may be cited here.

In the first place the water in the cold diffusion residue must be raised to the temperature of the body of the animal. The heat for this must come from the combustion of the food. The authors estimate, for instance, that in the experiments with sheep in series S (see page 651), the excess of consumption of water daily with the wet food over that with the dry food amounted to 1.8 kg. per head, and that the wet diffusion residue had a temperature of from 5° to 10° C., so that this excess of water must be warmed 32.5° to 27.5° in the body, for which the potential energy of from 14.8 to 12.5 gr. of starch would be required. Though this amount is not large, it is worthy of consideration.

Again, with increase of water consumption there is increase of evaporation from the skin and lungs. For changing this excess of water to the form of vapor, still more heat is required. How much of the excess of water consumed would be excreted in the form of water through the kidneys and intestines and how much as vapor from the lungs and skin, it is impossible to say. From earlier experiments by Henneberg, Maercker had assumed that 40 per cent of the excess of water would be excreted in the latter manner, but experiments lately published by Vogel* imply that it is much less. The amount of water evaporated from the lungs and skin must be considerable and must increase with the amount consumed by the animal. In the average of Vogel's experiments with sheep, 23.57 per cent of the total water consumed was evaporated through the lungs and skin. In the experiments of series S and T the extra quantities of water with the wet diffusion residue were 1.4 and 1.8 kg. per head per day respectively. Assuming that 23.57 per cent of the whole water consumed in each case was evaporated from the lungs and skin, the extra amount evaporated would be in the one case 0.33 and in the other 0.42 kg. The amounts of heat required for evaporating this water are estimated to be those corresponding to the potential energy of 49 and 62 gr. of starch, respectively. Or, to make the statement in a form more easily understood by practical feeders, the increase of water consumption with the wet residue would involve an increased evaporation, for which as much starch would have to be burned in the body as would be contained in 103 gr. of wheat bran in the one case and 130 in the other. In other words, it would by this estimate require the carbohydrates of from 4 to 5 ounces of bran per day to provide for the extra water evaporation by each sheep eating diffusion residue.

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*Journ. f. Landw., 39 (1891), p. 39.

It has been claimed that with increased water consumption and consequent increase of the quantity of blood in the body there is a corresponding increase of work required to keep the blood in circulation, and that for this purpose more of the energy of the food will be used. But the exact experimental knowledge of this subject is too vague to allow of exact estimate of the consumption of energy.

The most important disadvantage from the excessive water consumption is perhaps the increased metabolism of nitrogen which is induced thereby. In proportion as more nitrogen is transformed, less is stored in the body, and in consequence there is less gain or more loss of (lean) flesh. In referring to this as an established principle, the authors cite the results of a number of observations by Mares* with men, which imply that the increased nitrogen metabolism with increased water consumption is greater the smaller the quantity of protein in the food. Instances are cited from the experiments by the Halberstädter agricultural society, in which increase of water in the ration was accompanied by diminution in gain or by actual loss of live weight of the animals. The results, as tabulated, were as follows:

Water in total fodder; change in live weight and milk produced per head per day.

	Water consumed.	Gain or loss in live weight.	Milk yield.
	Pounds.	*Pounds.*	*Pounds.*
Series H, fattening oxen	85.6	3.49	....
	97.9	2.75	....
Series A, milch cows	43.3	1.29	27.39
	62.7	0.21	29.61
	81.6	−0.01	31.13

"We can not estimate exactly the extent of the unfavorable effect of a given excess of water in the food upon the live weight of an animal, but there is no doubt that a large amount does interfere with the storage of protein to a certain and probably very considerable extent. * * * When the excess is repeated day after day its effect upon the destruction of protoplasm may be such as to cause notable loss of flesh. To prevent this loss larger quantities of protein must be supplied in the food, and its place can not be filled by carbohydrates and fats."

Special disadvantages of overfermented food.—The authors call attention to the bad effects of the fermented diffusion residue upon dairy products and its tendency to induce disease. The considerations are of interest as illustrating the disadvantages of overfermented silage in general.

Manifold investigations show that the ill-smelling and ill-tasting fermentation products injure the taste and keeping qualities of milk, butter, and cheese. It is not that they pass directly into the milk through the lacteal glands, "but in the stable in which the material is fed the microscopic organisms that cause the fermentation are

* Ungarischer Arch. f. Medizin, 1888; also Centralbl. f. agr. Chem., 1891, p. 175.

distributed through the air in large numbers, get on the hands and clothes of the milkers [and the udder and teats of the cow], are thus conveyed to the milk, find their way into the butter, cause ill-tasting compounds to be formed, and injure its keeping quality. That the sugar beet districts of Germany are characterized by very poor butter, there is no doubt." This, the authors imply, is due, in part at least, to the cause above explained.

A number of diseases of cattle and sheep are likewise named by the authors as apt to be induced by the organisms which find most favorable conditions for development in the fermenting diffusion residue and in the very wet manure produced from it. The observations of veterinarians are quoted which indicate that the danger of disease is much less in feeding the dry than the wet residue.

Drying of diffusion residue.—The drying of the residue is very effectually accomplished by the apparatus referred to. This consists essentially of two parts, a furnace in which brown coal or other fuel is burned, and drying chambers in which the wet residue is exposed to the hot draft from the fire. Arrangements are provided to keep the material in motion and thus secure more rapid drying, and to admit cold air into the chambers so as to lower the temperature when the material is nearly dry and thus prevent its being injured by the heat.

The report gives results of investigations of the composition and digestibility of the dry residue which are very favorable for the drying process.

Feeding experiments with wet vs. dry diffusion residue.—A number of patrons of the sugar factory at Hadmersleben desiring to obtain by personal experience an insight into the feeding value of the dry residue as compared with the ensiled residue which they had been using, arrangements were made for coöperative experiments. Several other proprietors or managers of large sugar beet farms joined with them, and several series (O–V) of experiments with milch cows and fattening oxen and sheep were planned and carried out in 1889 under the direction of Professor Maercker and Dr. Morgen of the Halle Station.

Each experiment with cows included a preliminary period and three test periods, the latter being separated by transition periods. The test periods were 10 days each and the transition periods of the same or nearly the same length. Of the test periods the first and third were with wet and the second with dry, or the first and third with dry and the second with wet residue. The results of the first and third were taken together and compared with those of the second, to elminate as far as practicable the effect of the change of the milk during the period of lactation. In the experiments with fattening oxen or sheep, the animals were divided into two (in one case three) equal lots, one receiving the wet and the other the dry residue.

In each series a basal ration of coarse and concentrated foods was used, and to this was added either the wet or the dry residue. The

rations for each series were so adjusted as to contain as nearly as practicable the same quantity of digestible nutrients in the different periods, so that the only difference should be in the amount of water in the diffusion residue. The feeding stuffs were analyzed and the quantities of digestible nutrients determined or estimated by the station. Before the beginning of the feeding tests each experimenter set aside a sufficient quantity of coarse food—hay, straw, chaff, etc.—and samples were taken for analysis. A supply of each of the concentrated foods—oil cake, meal, etc.—sufficient for all the experiments, was obtained from a single source, a sample analyzed, and portions distributed among experimenters. A sample of the dry residue used by each experimenter was analyzed. As the wet residue varied in composition special means were adopted for frequent analyses of the material used in each case. This caused some inconvenience and a little disturbance of the unity of the trials on account of the difficulty in determining the composition before the material was fed.

The quantities of the materials fed were calculated from the percentages of digestible nutrients. The methods of estimating the rations and the financial results are given in detail in the report. They will be found decidedly helpful in the planning of similar experiments elsewhere. The estimates of cost of feeding stuffs and value of products are based upon figures similar to those above quoted for the experiments of series A–N. The details of the composition of the feeding stuffs and of the results of the experiments are given in tabular form. The results of the experiments are summarized in tabular statements which are given below.

Experiments with milch cows.—From the figures in the tables it will be seen that the rations in series O were liberal, and although the quantities of nutrients in series P are less, they exceed those of Wolff's standards, except in period III, in which, owing to variations in the composition of the wet residue, they could not be determined in season to make the proper allowance in the making up of the ration. On this account the results for period III can not be averaged with those of period I to make up for the change in the composition of the milk with the advance of the period of lactation. Of these two series the authors say:

"Unfortunately only one of the experiments is available. Furthermore the duration was too short for satisfactory conclusions as to increase in live weight. For estimating the effects upon milk production, likewise, the periods of 10 days each are far too short. A more reliable estimate could be made from trials extending through longer periods. The best plan, if practicable, would be to divide the herd in the stable into two lots and feed one lot with wet and the other with the dry residue." Nevertheless the conclusions seem warranted that in series O "the feeding with dry residue exercised an extraordinarily favorable influence upon the bodily condition of the cows," and that in series B the effect was likewise very favorable.

Series O.—Experiments with wet vs. dry diffusion residue.—Conducted by Herr Wrede in Schmerke.—Six cows averaging 1,118 pounds live weight. Three feeding periods of 10 days each, with first transition period 10, second 5 days. Basal rations per head per day in pounds, potato residue 66, hay 5.5, chaff 4.4, straw 6.6, palm nut oil meal 2.2, cotton-seed meal 2.8 to 3.5, wheat bran 2.8 to 6.5, and wet or dry beet diffusion residue added to this in quantities as stated. Duration of experiment from March 6 to April 17—42 days.

Rations; yield of milk; gain in live weight; financial results.

	Periods.		
	I.	II.	III.
Quantities per head per day added to basal ration:			
Wet diffusion residue ... pounds	55.00	....	55.00
Dry diffusion residue ... do	....	9.92	....
Digestible nutrients in total food:			
Per head per day—			
Protein ... do	3.85	3.96	4.14
Non-protein ... do	18.5	19.18	18.94
Per 1,000 pounds live weight per day—			
Protein ... do	3.44	3.54	3.70
Non-protein ... do	16.56	17.17	16.95
Nutritive ratios	1:4.8	1:4.8	1:4.6
Potential energy in digestible nutrients per 1,000 pounds live weight per day ... Calories	41,000	42,450	42,330
Milk yield per head per day ... pounds	37.47	39.25	39.53
Gain in live weight per head per day ... do	0.15	2.90	0.23
Financial gain per head per day ... cents	12.0	13.5	12.0

Series P.—Experiments with wet vs. dry diffusion residue.—Conducted by Herr Schäfer in Wanzleben. Ten cows averaging 1,203 pounds live weight. Three feeding periods of 10 days each with transition periods of same length. Basal ration per head per day in pounds, hay 5.5, chaff 7, palm nut meal 3.3, cotton-seed meal 1.8 to 3.4, wheat bran 3.3 to 6.7, and wet or dry diffusion residue added to this in quantities as stated. Duration of experiment from March 1 to April 20—50 days.

Rations; yield of milk; gain in live weight; financial results.

	Periods.		
	I.	II.	III.
Quantities per head per day added to basal ration:			
Wet diffusion residue ... pounds	66.00	....	66.00
Dry diffusion residue ... do	....	9.97	....
Digestible nutrients in total food:			
Per head per day—			
Protein ... do	3.45	3.30	2.79
Non-protein ... do	15.70	15.09	13.71
Per 1,000 pounds live weight per day—			
Protein ... do	2.87	2.74	2.32
Non-protein ... do	13.05	12.54	11.39
Nutritive ratios	1:4.5	1:4.6	1:4.9
Potential energy in digestible nutrients per 1,000 pounds live weight per day ... Calories	32,640	31,330	28,105
Milk yield per head per day ... pounds	27.94	29.22	27.94
Gain in live weight per head per day ... do	0.23	1.97	2.52
Financial gain per head per day ... cents	4.7	4.0	....

Experiments with fattening oxen.—Series Q differs from the others in having three lots instead of two. The object of lot 3 was a test of the question whether the hay of the basal ration could be replaced by the dry residue, an extra amount of the latter being used for this purpose. As the hay used for lots 1 and 2 was richer in protein than the dry residue, this deficiency in the latter was made up by lupines. The results were most favorable for the dry residue. In series R the animals did not consume the dry residue completely at first and the difference had to be made up with concentrated fodder, and furthermore the duration of the experiment was shortened by warm weather the middle of April. Hence the results are not as satisfactory as they would otherwise have been. The outcome of the two series is favorable both for the dry residue and for the more liberal feeding.

Series Q.—Experiments with ensiled vs. dried diffusion residue.—Conducted by Herr Rimpau in Schlanstedt. Fifteen young steers divided into three lots of five each. In estimates of results the animal in each lot having the smallest increase in live weight, was left out of account. The remaining four animals in each lot averaged 1,025, 1,012, and 997 pounds live weight, respectively. Basal ration per head per day in pounds, hay 5.5 (lot 3 none), chaff 6.2 to 6.8, rice meal 1.1 to 5.1, lupines 3.1 to 4.2, potato residue from 44 to 66, and ensiled or dry beet diffusion residue in quantities as stated. Duration of experiment from January 28 to April 28—91 days.

Rations; gain in live weight; financial results.

	Lots.		
	1.	2.	3.
Quantities per head per day added to basal ration:			
Ensiled diffusion residue .... pounds..	44	....	....
Dried diffusion residue .... do....	....	11.40	15.25
Digestible nutrients in total food:			
Per head per day—			
Protein .... do....	3.34	3.28	3.23
Non-protein .... do....	15.29	15.25	15.22
Per 1,000 pounds live weight—			
Protein .... do....	3.26	3.24	3.25
Non-protein .... do....	14.91	15.07	15.28
Nutritive ratios	1:4.6	1:4.7	1:4.7
Potential energy in digestible nutrients per 1,000 pounds live weight per day .... Calories..	37,260	37,525	37,965
Gain in live weight per head per day .... pounds..	2.64	3.04	3.17
Financial gain per head per day .... cents..	6.6	10.1	12.0

Series R.—Experiments with wet vs. dry diffusion residue.—Conducted by Herr Kastendiek in Ampfurt. Ten oxen of Bavarian breed averaging 1,507 and 1,448 pounds live weight, respectively, divided into two lots of five each. Basal ration per head per day in pounds, hay 5.5, chaff 2.6 to 4.4, straw 1.1 to 2.2, cotton-seed meal 4.4, rice meal 2.9 to 7.3, and wet or dry diffusion residue in quantities as stated. Duration of experiment from February 25 to April 15—49 days.

Rations; gain in live weight; financial results.

	Lots.	
	1.	2.
Quantities per head per day added to basal ration:		
Wet diffusion residue .... pounds..	88	....
Dry diffusion residue .... do....	....	6.12
Digestible nutrients in total food:		
Per head per day—		
Protein .... do....	3.28	3.21
Non-protein .... do....	16.28	13.90
Per 1,000 pounds live weight—		
Protein .... do....	2.18	2.22
Non-protein .... do....	10.80	9.60
Nutritive ratios	1:5.0	1:4.3
Potential energy in digestible nutrients per 1,000 pounds live weight per day .... Calories.	26,605	24,240
Gain in live weight per head per day .... pounds..	2.13	2.53
Financial gain per head per day .... cents..	8.0	10.0

Experiments with fattening sheep.—Of these little need be said except that they confirm in a striking way the superior value of the dry residue, and thus agree with the other experiments.

Series S, T, U, and V.—Wet vs. dry diffusion residue.—Series S conducted by Herr Heine in Hadmersleben, series T by Herr Heine in Emersleben, series U by Herr Kotze in Klein Oschersleben, series V by Herr Kastendiek in Ampfurt. In each series 20 sheep divided into two lots of 10 each. One lot received wet and the other dry diffusion residue added to the basal ration.

Live weight of animals; basal rations; duration of experiments.

	Series.							
	S.		T.		U		V.	
	Lots.		Lots.		Lots.		Lots.	
	1.	2.	1.	2.	1.	.	1.	2.
Live weight at beginning of experiment	*Lbs.* 924	*Lbs.* 904	*Lbs.* 968	*Lbs.* 968	*Lbs.* 1,082	*Lbs.* 1,056	*Lbs.* 1,093	*Lbs.* 1,056
Basal ration per lot (10 head) per day:								
Potato residue	43.1	43.1	....	....	....	....	....	....
Pea straw	5.3	4.8	8.8	8.8	5.5	5.5	8.8	8.8
Chaff	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
Lupines	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Poppy cake	2.0	2.4	3.1	4.6	3.5	4.6	3.7	5.1
Rice meal	4.0	2.2	7.7	3.3	7.0	3.3	6.2	3.3
Duration of experiment	Feb. 21–June 1—101 days.		Feb. 17–May 20—93 days.		Feb. 25–Apr. 29—63 days.		Feb. 25–Apr. 29—63 days.	

Diffusion residue added to basal rations; nutrients in total rations; gains in weight; financial results.

	Series.							
	S.		T.		U.		V.	
	Lots.		Lots.		Lots.		Lots.	
	1.	2.	1.	2.	1.	2.	1.	2.
Quantities (per head) per day added to basal ration:								
Wet diffusion residue . pounds..	64.68	....	88.00	....	88.00	....	88.00	....
Dry diffusion residue....do....	....	11.99	....	13.27	....	13.40	....	12.67
Digestible nutrients in total food:								
Per ten head per day—								
Protein ....pounds..	3.59	3.67	3.70	3.89	44.53	3.83	3.76	3.98
Non-protein..........do....	15.97	16.74	17.49	17.14	18.41	16.52	19.80	17.38
Per 1,000 pounds live weight—								
Protein ....pounds..	3.88	4.06	3.82	4.02	3.74	3.63	3.44	3.77
Non-protein ....do....	17.29	18.52	18.07	17.70	17.01	15.65	18.11	16.46
Nutritive ratios	1:4.6	1:4.6	1:4.8	1:4.4	1:4.6	1:4.3	1:5.3	1:4.4
Potential energy in digestible nutrients per 1,000 pounds live weight per day ....Calories..	43,390	46,285	44,865	44,540	42,540	39,505	44,175	41,470
Gain in live weight per ten head per day..................pounds..	2.65	3.36	1.98	2.12	2.84	3.17	3.17	3.70
Financial gain or loss (—), per ten head per day ....cents..	7.0	11.9	—0.5	4.6	7.4	10.7	7.9	13.3

Results of experience. Feeding rations.—The information obtained from the experiments was supplemented by collating from twenty or more farms the results of actual experience in feeding wet and dry beet residue to different classes of animals. The data obtained in this way are given in detail and agree with the more exact experimental results. Thus the value of the latter is materially augmented. To make the teachings more useful to the practical feeder, the report includes a considerable number of daily rations for milch cows, fattening oxen, draft oxen, and fattening sheep. These are so calculated as to contain different quantities of dry diffusion residue combined with such coarse and concentrated foods as the farmers of the region find advantageous.

Inferences regarding the feeding of diffusion residue.—The report summarizes the results in a number of definite statements which are extremely favorable to the drying of the residue.—[W. O. A.]

Dairy investigations at the Institute for Animal Physiology, Royal Agricultural School, Vienna, L. Adametz, and M. Wilckens (*Landw. Jahrb., 21 (1892), pp. 131–148*).—These investigations included trials of hand milk separators, comparison of butter from sweet and from sour cream, and experiments with the use of pure cultures in butter making.

In the tests with hand separators a sample of freshly drawn milk was found to cream more thoroughly than the samples which came from a distance and were several hours old, from which the authors infer that transportation diminishes creamability of milk by the centrifuge.

Seven trials were made, in each of which the sample of fresh cream was divided, one part being churned while still sweet and the other kept for a time, usually until quite sour. In all cases the fat separated more completely from the sour cream than from the sweet cream in churning, as was shown by the analyses of buttermilk. The sweet cream butter was mostly soft or of abnormal consistency and did not keep as well as the sour cream butter. Two trials, made to determine whether the more thorough separation of the fat in churning is regulated by the age of the cream or by its acidity, indicated that below certain limits of acidity (not fully determined) the age of the cream was the controlling factor.

Adametz suggested that possibly in keeping cream for a long time, especially at a low temperature, the fat globules might crystallize, in a measure, and favor a more complete churning. Seen under the microscope, the larger fat globules took on an irregular, notched outline. If this theory were true the butter yield from very fresh cream, in which this crystallization of the fat globules could hardly have begun, might be expected to be exceedingly poor, and in fact this was found to be the case, the buttermilk from a cream only an hour and a half old containing 7 per cent of fat.

In the studies of the effect on the butter of souring the cream by means of pure cultures of bacteria, some sixteen tests were made, using pure cultures of "milk yeast" (*Saccharomyces lactis*, Adametz), Quist's lactic acid bacteria, or a mixture of the two, and in one case *Tyrothrix tenuis*, a form used in ripening certain French cheeses, and said to impart to the butter a mild aroma. The fermentation products of the milk yeast are given as ethyl alcohol and traces of acetic acid and fruit ethers. These ferments were added to separate portions of cream in varying amounts, and the cream allowed to ripen for different lengths of time. The butter churned from the ripened cream was submitted to a committee for testing and was tested as to keeping quality. The cows producing the milk were fed silage, and where pure cultures were not used the butter tasted of the food. As a general result of the addition of lactic acid bacteria and milk yeast to the cream, the butter was improved in taste and keeping qualities, and retained no taste of the food (especially of silage). It is stated that the fermentation of the milk sugar induced by milk yeast can be held in check by the addition of lactic acid bacteria.

TITLES OF ARTICLES IN RECENT FOREIGN PUBLICATIONS.

The alkaloids of the barberry (*Ueber Berberisalkaloide*), C. RÜDEL.—*Arch. der Pharmazie, 229, pp. 651–666.*

The alkaloids of the betel nut (*Ueber die Alkaloide der Arekanuss*), E. JAHNS.—*Arch. der Pharmazie, 229, pp. 669–707.*

A search for a cellulose-dissolving (cytohydrolytic) enzyme in the digestive tract of certain grain-feeding animals, H. T. BROWN.—*Proc. Chem. Soc., 1892, pp. 30–33.*

Determination of nitric nitrogen (*Zur Bestimmung der Nitratstickstoffs*), K. ULSCH.—*Zeitsch. f. angew. Chem., 1891, p. 718.*

The quantitative determination of nitrogen in nitrate of soda (*Die quantitative Bestimmung des Stickstoffs im Natronsalpeter*), ALBERTI AND HEMPEL.—*Zeitisch. f. angew. Chem., 1892, Heft 4, pp. 101–104.*

A new method of analysis of organic substances (*Sur une nouvelle méthode d'analyse organique*), BERTHELOT.—*Compt. rend., 114 (1892), pp. 317, 318.*

Determination of the freezing point of very dilute aqueous solutions; application to cane sugar (*Détermination du point de congélation des dissolutions aqueuses très diluées; application au sucre de canne*), RAOULT.—*Compt. rend., 114 (1892), pp. 268–271.*

A new form of fat-extraction apparatus for liquids, A. SMETHAM.—*Analyst, March, 1892, pp. 44, 45, fig. 1.*

Fat extraction and fat calculation in milk analysis, H. D. RICHMOND.—*Analyst, March, 1892, pp. 48–52.*

A new means for recognizing fatty oils in lard (*Ueber eine neue Reaktion zur Erkennung von fetten Oelen im Schweineschmalz*), P. WELMANS.—*Pharm. Ztg., 36, pp. 798, 799.*

A sensitive reagent for albumen in urine (*Eine empfindliche Reaction auf Eiweiss im Harne*), E. SPIEGLER.—*Ber. d. deut. chem. Ges., 25 (1892), Heft 3, pp. 375–378.*

A convenient method for arranging the apparatus used in determining free and albuminoid ammonia, G. EMBREY.—*Analyst, March, 1892, pp. 41–43, fig. 1.*

Silica in plants (*Sur la silice dans les végétaux*), BERTHELOT and ANDRÉ.—*Compt. rend., 114 (1892), pp. 257–263.*

On the presence and function of sulphur in plants (*Sur la présence et sur le role du soufre dans les végétaux*), BERTHELOT and ANDRÉ.—*Ann. Chim. et Phys., tom 25, sér. 6, pp. 341–363.*

The substances accompanying chlorophyll in leaves (*Des principles qui accompagnent la chlorophylle dans les feuilles*), A. ETARD.—*Compt. rend., 114 (1892), pp. 364–366.*

Development and significance of the root tubercles of Leguminosæ (*Die Entwickelung und Bedeutung der Leguminosenknöllchen*), A. KOCH.—*Fühling's landw. Ztg., 1892, Heft 4, pp. 124–132, fig. 1.*

The fixation of atmospheric nitrogen by the soil and plants (*Sur la fixation de l'azote atmosphérique par le sol et les végétaux*), A. GAUTIER and R. DROUIN.—*Bul. Soc. Chim. de Paris, tom 7, 8, sér. 3, pp. 84–97.*

Studies on the action of fluorides on yeasts, J. Effront.—*Monit. scientif., 5, pp. 1137–1144.*

Digestive ferments in the fetus of the cow and the sheep, and in newly born dogs and cats (*Die Verdauungsfermente beim Embryo und Neugeborenen*), F. Krüger.—*Centralbl. f. Physiol., 5, p. 612.*

On the determination of mineral substances in humus and on their function in agriculture—a method of analysis (*Sur le dosage des matières minerales contenus dans la terre végétale et sur leur role en agriculture—Methode d'analyse*), Berthelot and André.—*Ann. Chim. et Phys., tom 25, sér. 6, pp 289–314.*

The history of the nitrogenous substances contained in humus (*Faits pour servir à l'historie des principes azotés renfermés dans la terre végétale*), Berthelot and André.—*Ann. Chim. et Phys., tom 25, sér. 6, pp. 314–336.*

The nature of the sulphur compounds in the soil (*Sur la nature des composés sulfurés contenus dans le sol*), Berthelot and André.—*Ann. Chim. et Phys., tom 25, sér. 6, pp. 336–341.*

Investigations on humic substances (*Recherches sur les substances humiques*), Berthelot and André.—*Ann. Chim. et Phys., tom 25, sér. 6, pp. 364–403.*

Calorimetric investigations on the humic acid derived from sugar (*Recherches calorimétriques sur l'acide humique dérivé du sucre*), Berthelot and André.—*Ann. Chim. et Phys., tom 25, sér. 6, pp. 403–420.*

Comparative nitrification of humus and of purely organic materials, and the influence of the proportion of nitrogen in humus on nitrification (*Nitrification comparée de l'humus et de la matière organique non altérée, et influence des proportions d'azote de l'humus sur la nitrification*), P. Pichard.—*Compt. rend., 114 (1892), pp. 490–493.*

The formation and behavior of basic calcic phosphate and its connection with Thomas slag (*Bildung und Verhalten basischer Calciumphosphate und ihre Beziehungen zur Thomasschlake*), O. Förster.—*Zeitsch. f. angew. Chem., 1892, pp. 13–22.*

The manufacture of superphosphate from phosphates rich in arsenic (*Ueber Herstellung von Superphosphaten aus arsenreichen Phosphaten*), Schucht.—*Zeitsch. f. angew. Chem., 1891, pp. 667–671.*

Field experiments with barnyard manure preserved with superphosphate gypsum (*Feldversuche mit Superphosphatgyps-Mist*), J. R. Schiffer.—*Zeitsch. d. landw. Ver. f. Rheinpreussen, 1892, pp. 43, 44.*

Effect of increasing amounts of nitrate of soda on the yield of rye (*Wirkung gesteigerter Chilisalpeterdüngungen auf die Roggenernte*), G. Marek.—*Wiener landw. Ztg.; abs. in Braunschwg. landw. Ztg., 1892, p. 14.*

Nitrogenous fertilizers for winter grain (*Die Stickstoffdüngung für Wintergetreide*), A. Leydhecker.—*Oesterr. landw. Wochenbl.; abs. in Braunschwg. landw. Ztg., 1892, pp. 5, 6.*

Variations in the composition of Jerusalem artichoke (*Des variations de composition du topinambour*), G. Lechartier.—*Ann. Agron., 1892, tom 18, pp. 68–91.*

Chemical composition of light and heavy oats (*Chemische Zusammensetzung des "leichten" und "schweren" Hafers*), R. Heinrich.—*Landw. Ann. d. meck. pat. Vereins, 1892, No. 6, pp. 46–49.*

Composition and value as food of tubers of Stachys tuberifera (*Zusammensetzung u. Nährwert der Knollen von Stachys tuberifera*), F. Strohmer and A. Stift.—*Oesterr. ungar. Zeitsch. f. Zucker-Ind. u. Landw., 20, p. 803.*

New varieties of potatoes (*Nouvelles variétés de pommes de terrre*), A. Dubois.—*Jour. d'Agr. prat., 1892, tom 1, pp. 282, 283.*

Improvement of potatoes by selection of seed tubers rich in starch (*Die Verbesserung der Kartoffelsorten durch Auswahl stärkereicher Mutterknollen*), E. Marek.—*Fühling's landw. Ztg., 41 (1892), Heft 5, pp. 164–171, and Heft 6, pp. 209–214.*

Improvement in the culture of potatoes in France; results of the campaign of 1891 (*Amélioration de la culture de la pomme de terre industrielle et fourragère en*

France; résultats de la campagne 1891), A. GIRARD.—*Compt. rend., 114 (1892), pp. 366–368.*

Coöperative field experiments with potatoes, beets, and turnips at Borsbeke, Belgium (*Expériences pratiques exécutées en 1891, à Borsbeke-lez-Alost*), P. DE VUYST.—*Brussels, 1892, 15.*

Investigation of the effect of stripping off the leaves of the vine on the ripening of grapes (*Recherches sur l'effeuillage de la vigne et la maturation des raisins*), A. MÜNTZ.—*Compt. rend., 114 (1892), pp. 434–437.*

Report of the feeding-stuffs control at the experiment station at Hohenheim for 1891 (*Bericht über die Kontrolle des Futtermittelhandels in Würtemberg, 1891*), E. WOLFF.—*Würtemb. Wochenbl. f. Landw., 1892, No. 8, pp. 81–85.*

Gases in the paunch of cattle after eating different kinds of feeding stuffs (*Die Gase des Rinderpansens nach dem Genusse verschiedner Futtermittel, mit Berücksichtigung des akuten Aufblähens und dessen Behandlung durch gasabsorbierende Arzneimittel*), M. LUNGWITZ.—*Arch. f. Tierheilkunde, 18, pp. 80–110.*

Linseed cake *vs.* **sesame cake for milch cows.**—*Wekelijsche Landbouw Kroniek; abs. in Braunschwg. landw. Ztg., 1892, No. 8, p. 31.*

The variations in the composition of milk from fractional milkings at irregular intervals (*Untersuchungen über die Schwankungen in der Zusammensetzung der Milch bei gebrochenem Melken*), H. KAULL.—*Abs. in Milch Ztg., 1892, No. 7, p. 104.*

The reactions of cows' milk and human milk, and the relation of these to the reactions of casein and phosphate (*Ueber die Reaction der Kuh- und Frauenmilch und ihre Beziehungen zur Reaction des Caseins und der Phosphat*), G. COURANT.—*Arch. f. d. ges. Physiol., 50, pp. 109–165.*

Germ content of human milk (*Ueber den Keimgehalt der Frauenmilch*), M. COHN and H. NEUMANN.—*Virchow's Arch., 126, pp. 391–406.*

The specific gravity of textile fibers (*Le poids spécifique des fibres textiles*), L. VIGNON.—*Compt. rend., 114 (1892), pp. 424, 425.*

The density of textile fibers (*Sur la densité des textiles*), DE CHARDONNET.—*Compt. rend., 114 (1892), p. 489.*

An improvement in the automatic apparatus used in irrigation for raising water to a great height (*Sur une amélioration de l'appareil automatique à elever de l'eau à de grandes hauteurs, employé aux irrigations*), ANATOLE DE COLIGNY.—*Compt. rend., 114 (1892), pp. 397, 398.*

Report of the experiment station at Brunswick, Germany, for 1891 (*Bericht über die Thätigkeit der Landwirtschaftlichen Versuchs-Station in 1891*), H. SCHULTZE.—*Braunschwg. landw. Ztg., 1892, p. 13.*

Report of the experiment station at Münster, in Westphalia, Germany, for 1891 (*Bericht über die Thätigkeit der landw. Versuchs-Station in Münster, 1891*), J. KÖNIG.—*Landw. Ztg. f. Westfalen u. Lippe, 1892, No. 8, pp. 62–64, and No. 9, p. 70.*

Report of the seed-testing station at Hohenheim for the year ending October 1, 1891 (*Jahresbericht der k. Samenprüfungs-Anstalt Hohenheim*), O. KIRCHNER.—*Würtemb. Wochenbl. f. Landw., 1892, No. 3, pp. 23-26, and No. 4, pp. 33, 34.*

Third annual report of the Halle station for experiments in the repression of nematodes, 1891 (*Dritter Jahresbericht der Versuchs-Station für Nematoden-Vertilgung*), M. HOLLRUNG.—*Halle, pp. 35.*

EXPERIMENT STATION NOTES.

Colorado College.—A. Ellis, Ph. D., LL.D., has accepted the presidency of the college for a term of 5 years. Dr. Ellis was born on a farm in Kenton County, Kentucky, in 1847; graduated at Miami University, Oxford, Ohio, in 1867; and after teaching in Kentucky for several years he became superintendent of schools at Hamilton, Ohio. He afterwards held a similar position at Sandusky, Ohio, but in 1887 was called back to his old position at the head of the Hamilton schools, which he has held up to the present time. He has been active as a worker in teachers' institutes, and as a lecturer at farmers' institutes. He also served for 5 years as a member of the board of trustees of the Ohio State University.

Georgia Station.—H. J. Wing of Auburn, Ohio, has been elected dairyman of the station. The station laboratory is now equipped for work, and will be in charge of the assistant chemist, R. E. Hardee. It is proposed to erect a tobacco barn and to undertake field experiments with tobacco in view of the fact that the farmers of the State are becoming interested in the culture of this plant.

Illinois Station.—S. A. Forbes, Ph. D., has been appointed a member of the board of direction. The report of the State entomologist, covering the years 1889 and 1890, has recently been issued by Dr. Forbes. The report includes articles on the history, description, and life history of the fruit bark beetle (*Scolytus rugulosus*), with suggestions regarding remedies and abstracts of the literature on this insect; feeding and insecticide experiments with the plum and peach curculio (*Conotrachelus nenuphar*); descriptive notes on the American plum borer (*Euzophera semifuneralis*), with references to literature; notes on the life history of common white grubs of the genera *Lachnosterna* and *Cyclocephala*, their food and feeding habits; experiments with remedies, accounts of parasites and description of a few species, and a list of 31 species of *Lachnosterna* found in Illinois, with a key to these species; additional notes on the life history of the Hessian fly (*Cecidomyia destructor*), with a table of results of new and old breeding-cage experiments, and a brief account of experiments in breeding the fly on grasses; a summary history of the corn root aphis (*Aphis maidi-radicis*); notes on a bacterial disease of the larger corn root worm (*Diabrotica 12-punctata*); descriptive notes on the diseases of the chinch bug (*Micrococcus insectorum* and *Sporotrichum globuliferum*), with accounts of culture and infection experiments, and abstracts from recent literature on this subject. An appendix contains an analytical list of the entomological writings of W. Le Baron, M. D., the second State entomologist of Illinois. The report is illustrated with four plates containing 23 figures and a portrait of Dr. Le Baron.

Massachusetts College.—The Twenty-Ninth Annual Report of the college, issued in January, 1892, contains, in addition to the formal reports of its several departments, articles on military instruction in educational institutions, by L. W. Cornish, and on tuberculosis, especially as affecting domestic animals, by J. B. Paige, B. S.

Massachusetts Horticultural Society.—At a recent meeting of this society W. E. Endicott read a paper on the library of the society, which contains many rare and valuable works. The society desires that all persons who are interested in horticultural subjects should avail themselves of this library "as fully and freely as is

consistent with its preservation." As a mark of its interest in this matter the society voted that a copy of Mr. Endicott's paper should be sent to each of the horticultural societies and agricultural experiment stations in the country.

MICHIGAN COLLEGE AND STATION.—P. M. Harwood, M. S., has been appointed professor of agriculture in the college and agriculturist to the station; F. B. Mumford, B. S., has been appointed assistant in agriculture; and R. J. Coryell, B. S., assistant in horticulture.

PENNSYLVANIA COLLEGE AND STATION.—H. J. Waters of the Missouri Station has been appointed professor of agriculture in the college and agriculturist of the station vice T. F. Hunt, B. S. G. L. Holter, B. S., assistant chemist, has accepted the position of professor of chemistry in the Oklahoma College, and chemist to the station connected with that institution, and E. J. Haley has taken his place as assistant chemist to the Pennsylvania Station.

UTAH COLLEGE AND STATION.—The legislature of the Territory has appropriated $108,000 for the erection of college buildings. Though it is only about 18 months since the college was opened, it has some 300 students. The station has added to its live stock pure-bred Shropshire sheep, Jersey, Shorthorn, and Angus cattle, and Berkshire pigs. J. Dryden has been appointed stenographer vice J. H. Walker.

VERMONT STATION.—C. W. Minott, B. S., has resigned his position as horticulturist of the station. D. D. Howe of Brookfield, Vermont, has been appointed superintendent of the farm.

WYOMING STATION.—A. A. Johnson, D. D., president of the University of Wyoming, has been elected director of the station vice D. McLaren, M. S., resigned.

BUREAU OF ANIMAL INDUSTRY.—A report has been made of the recent experiments in La Salle County, Illinois, with a view to testing the value of inoculation as a preventive of hog cholera. The results have brought out additional evidence of the danger of introducing and spreading the disease by the practice of inoculation.

DIVISION OF FORESTRY.—Among the investigations of timber carried on during the last 6 months, one series of tests has had for its object to determine the effect which the practice of gathering resinous material from pine trees may have upon the strength of the timber. The results of these tests are briefly stated in Circular No. 8 of the Division. Detailed accounts will be published when the tests are completed. The tests thus far made seem to show "that 'turpentine' timber, while exhibiting less tensile and shearing strength [and less stiffness], is stiffer than that from unboxed trees and has greater compressive and cross-breaking strength. At the same time it may be stated that turpentine timber proved itself harder to work, the resin collecting in spots, gumming up the tools."

CANADA.—A report on the production and manufacture of beet sugar has recently been issued by Prof. W. Saunders, director of the Dominion experimental farms. This contains the history of the industry in Europe, the United States, and Canada; a discussion of the relative cost of producing cane and beet sugar, with statistical information regarding bounties and the production of cane and beet sugar in different countries; accounts of improved varieties, methods of culture, cost of growing beets, value of the beet root and of waste pulp from the sugar factories for stock feeding, and the processes involved in the manufacture of beet sugar. It is calculated that it would require forty factories, employing from 8,000 to 9,000 hands, to produce the sugar required for consumption in Canada. An annual subsidy of about $4,000,000 would be required to put the industry on a profitable basis. The attempts to establish factories in Canada have, with perhaps one exception, proved financial failures. The greatest difficulty seems to have been that the farmers have not found the growing of the beets profitable enough to induce them to raise sufficient quantities to meet the requirements of the factories.

GREAT BRITAIN.—Among the documents of the board of agriculture recently received are the report on the distribution of grants to agricultural and dairy schools in Great Britain in 1890–91, with information regarding agricultural education in Belgium,

Switzerland, Germany, and France; agricultural returns of Great Britain and other countries; and a special report on the caterpillar of the diamond-back moth (*Plutella cruciferarum*).

Agricultural education.—During the fiscal year ending March 31, 1891, £4,840 were distributed by the board among 29 institutions in Great Britain, as follows: For dairy teaching, £1,945; agricultural experiments, £835; forestry or fruit growing, £150; general instruction in agriculture and dairying in connection with a collegiate course, £550; miscellaneous lectures, schools, teachers, classes, etc., £1,360. The board of agriculture having approached the University of Cambridge with a suggestion that some provision for training teachers in agriculture might be made at the university, a syndicate or committee of the authorities was appointed to consider the matter, who brought in a report. They think that the university should make provision for instruction in agriculture for regular members of the university, as well as for teachers and practical farmers who might wish to take partial courses. They advise the establishment of readerships in agricultural botany and chemistry, and of a board of examiners in agricultural studies to conduct examinations for honors, degrees, and certificates; to carry on agricultural experiments; and to provide for the analysis of seeds, feeding stuffs, manures, etc. In brief, this scheme would make the University of Cambridge a center of agricultural education.

At the University of Oxford, where a chair of rural economy already exists, steps are being taken with reference to the extension of facilities for agricultural education.

Agricultural statistics.—The following summaries of the agricultural statistics of the United Kingdom are taken from the report referred to above:

Acreage.	1891.	890.	1891 compared with 1890.	
			Increase.	Decrease.
	Acres.	*Acres.*	*Acres*	*Acres.*
Total cultivated area	48,179,473	48,045,755	133,718	....
Total permanent pasture	27,567,663	27,115,425	452,238	....
Total arable land	20,611,810	20,930,330	....	318,520
Corn crops	9,443,509	9,574,249	....	130,740
Green crops	4,510,653	4,534,145	....	23,492
Clover, etc., under rotation	6,013,685	6,097,210	....	83,525
Flax	76,477	99,326	....	22,849
Hops	56,145	54,555	1,590	....
Small fruit	60,138	46,733	13,405	....
Bare fallow	451,203	524,112	....	72,909
Live stock:	*No.*	*No.*	*No.*	*No.*
Horses	2,026,170	1,964,911	61,259	....
Cattle	11,343,686	10,789,858	553,828	....
Sheep	33,533,988	31,667,195	1,866,793	....
Pigs	4,272,764	4,362,040	....	89,276

Imports of live animals.

Year.	Cattle.	Sheep.	Pigs.	Value of cattle, sheep, and pigs imported.
	No.	*No.*	*No.*	£.
1870	202,000	670,000	96,000	4,655,000
1880	390,000	941,000	51,000	10,239,000
1890	643,000	358,000	4,000	11,216,000

Imports of dead meat.

Year.	Beef (fresh).	Mutton (fresh).	Bacon, hams, and pork.	All other forms of dead meat.	Value of imported dead meat.
	Cwt.	*Cwt.*	*Cwt.*	*Cwt.*	£.
1870	12, 000	....	824, 000	321, 000	3, 367, 000
1880	727, 000	....	5, 744, 000	1, 095, 000	16, 430, 000
1890	1, 855, 000	1, 656, 000	5, 300, 000	1, 114, 000	20, 225, 000

Imports of butter, margarine, cheese, and eggs.

Year.	Butter and margarine.	Cheese.	Eggs.	Value of butter, margarine, cheese, and eggs.
	Cwt.	*Cwt.*	*No.*	£.
1870	1, 159, 000	1, 041, 000	430, 842, 000	11, 170, 000
1880	2, 326, 000	1, 776, 000	747, 409, 000	19, 468, 000
1890	3, 108, 000	2, 144, 000	1, 234, 950, 000	22, 086, 000

Imports of grain, flour, and meal.

Year.	Wheat.	Flour.	Maize.	All other corn, meal, and flour.	Value of all corn, meal, and flour imported.
	Cwt.	*Cwt.*	*Cwt.*	*Cwt.*	£.
1870	30, 901, 000	4, 804, 000	16, 757, 000	21, 646, 000	34, 170, 000
1880	55, 262, 000	10, 558, 000	37, 225, 000	31, 128, 000	62, 857, 000
1890	60, 474, 000	15, 773, 000	43, 438, 000	35, 935, 000	53, 485, 000

FRANCE.—A report on the International Congress of Experiment Stations, held in connection with the Paris Exposition of 1889, has recently been issued by Messrs. L. and H. Grandeau. Besides the proceedings of the congress the report contains a large amount of statistical information regarding the history, organization, work, and publications of the experiment stations in France and other countries, and articles on special subjects in agricultural science.

BRAZIL.—Dr. M. Gerlach, formerly assistant at the experiment Station in Halle, Germany, has accepted a call from the Brazilian Government to establish in that country an agricultural experiment station on the plan of the Halle Station, and will proceed to Brazil immediately for that purpose.

TESTING PLATINIC CHLORIDE AS TO PURITY.—A. F. Holleman (*Chem. Ztg.*, 1892, p. 35) points out that while Krauch's manual for testing chemical reagents* requires only that platinic chloride should dissolve to a clear solution in alcohol and leave a residue, on evaporation, wholly insoluble in dilute nitric acid, these tests alone are insufficient to prove the purity of the reagent. He mentions having found sulphuric acid in platinic chloride put up by one of the best-known German manufacturers of chemicals, and which the tests given by Krauch indicated as pure. For use in quantitative potash determinations, according to the present methods, it is essential that the platinic chloride be absolutely free from this acid, for otherwise error may result from the formation of barium sulphate, from the traces of barium in the solution, along with the potassium-platinic chloride precipitate.

Martin slag and Thomas slag.—The Martin process for purifying crude iron ores, which differs in many respects from the Thomas-Gilchrist process, has recently been

*Dr. C. Krauch, Prüfung der chemischen Reagentien auf Reinheit.

introduced into several iron works in Germany. In outward appearance the ground slag resulting from the two processes closely resemble each other, and Martin slag is reported to have been frequently sold under the name of Thomas slag. The Bonn Experiment Station calls the attention of farmers to this, and pronounces it an adulteration, since the Martin slag contains, as a rule, only about 12 per cent of phosphoric acid, while Thomas slag should have 15 to 17 per cent or even more. A sample of Martin slag analyzed by the station contained 11.44 per cent of phosphoric acid, 40.86 per cent of calcium oxide, 14.31 per cent of silica, 17.85 per cent of ferric oxide, etc. No trials have yet been made as to the value of Martin slag for fertilizing purposes.

OLEOMARGARINE IN BERLIN.—The *Hannover land u. forstw. Ztg.* states that the consumption of oleomargarine in Berlin the past year reached at least 30,000,000 pounds, while the consumption of butter was about 70,000,000 pounds. Estimating the population at 1,500,000, this allows 20 pounds of oleomargarine and 46.6 pounds of butter per head. The use of artificial butter is said to have increased enormously within a few years. The effects are most felt by the small farmers. The remedy is believed to be in the establishment of well-conducted coöperative creameries, where, with the aid of machinery and the most improved appliances, a better quality of butter may be produced at a relatively less cost.

DAIRY SCHOOLS FOR MEN AND WOMEN.—A creamery school for men is to be opened April 1 in connection with the coöperative creamery at Güstrow for the instruction of pupils from Mecklenburg-Schwerin, Germany. Besides having a good common school education the applicants for admission must be at least 18 years of age and have had a year's experience in some creamery. The course covers 1 year and is divided into two terms. The students are to receive both practical and theoretical instruction in all matters relating to the handling of milk, together with instruction in the principles of feeding, the care of animals, machinery, and bookkeeping. Students attending both terms can afterwards enter the creamery as voluntary assistants for a longer or shorter time, but receive no regular theoretical instruction.

A dairy school for girls will also be opened at Badendick near Güstrow. Here also the training is to be both practical and theoretical, but it is intended more especially to fit women for dairy work on large farms rather than in creameries. The course covers 1 year.

A NEW ANNUAL ON FERMENTATION.—Volume 1 of the *Jahresbericht über die Fortschritte in der Lehre von den Gahrungs-Organizmen*, by Dr. A. Koch, Göttingen, has been received. In this annual an attempt has been made to review the current literature on fermentation, nitrification, and allied subjects. The subjects treated are, (1) handbooks; (2) methods of work, new apparatus, etc.; (3) morphology of bacteria and yeasts; (4) fermentation—alcholic, lactic, and other fermentations of milk and dairy products; uric acid, acetic acid, cellulose, bread, and other fermentations; nitrification, and the root tubercles of *Leguminosæ;* (5) ferments—diastase, invertin, pepsin, rennet, and urea ferment; (6) luminous bacteria.

The present volume is for the year 1890 and covers 190 pages, 55 of which are given up to reviews of recent literature on the fermentation of milk and dairy products, the use of pure cultures in dairying, sterilization of milk, fermentation of uric acid, nitrification, and root tubercles of *Leguminosæ;* and over 30 pages to ferments. The remainder is taken up largely with discussions of methods and apparatus, and alcoholic fermentation. The work is conveniently arranged, and contains a subject and name index.

ADULTERATION OF RAPE CAKE MEAL.—Many cases have recently been reported in Germany of adulteration of rape cake and rape cake meal. According to the Bonn Station the seed of the wild radish and Indian rape especially have been found as adulterants. The latter is characterized by its relatively high percentage of mustard oil, and may be detected by its pungent, burning smell when meal containing it is mixed with water and allowed to stand some time. In large amounts it renders the meal injurious for feeding.

Dr. Loges, director of the Posen Station, reports that out of 30 samples of rape cake meal examined only 6 were found pure. The remainder contained either no rape or only such small amounts that they could not properly be termed rape cake meal. Wild radish seed was the principal adulterant found.

BEETS FOR FEEDING.—Herr Simons, a farmer near Cologne, is reported (*Sächs. landw. Zeitsch., 1892, p. 68*) to have succeeded by continued selection in considerably increasing the percentages of sugar and of dry matter in the ordinary field beet used for feeding cattle. Two varieties have been produced, Simons, Lanker and Simons, Ovoïde des Berres. These contain over 11 per cent of sugar and only 82.2 per cent of water, as compared with 8–9 per cent of sugar and 88 per cent of water in the varieties commonly grown for feeding. The improved varieties are said to equal the older varieties in yield, and resemble the sugar beet in form. An analysis of the Lanker showed, besides the sugar, 4.58 per cent of nitrogen-free extract, 0.1 per cent of fat, 1 per cent of protein, and 0.8 per cent of ash in the fresh material. Simons recommends manuring for beets with barnyard manure to which ground bone has been added, but not with nitrate of soda, which he says is disadvantageous to the production of food material and to keeping quality of the roots.

COÖPERATIVE EXPERIMENTS IN TOBACCO CULTURE.—In accordance with an invitation from the German Potash Syndicate, representatives of the Governments of Prussia, Bavaria, Würtemberg, Baden, Hess, and Alsace-Lorraine, including in most cases the directors of experiment stations in the several states, and of the German Agricultural Society, the Mannheim Tobacco Union, and the German Potash Syndicate, met in conference at Carlsruhe, Baden, December 14, 1891, to consider the question of inaugurating a series of coöperative experiments on tobacco culture. After a protracted discussion the following articles were agreed upon:

(1) The experiments are all to be made on one general plan, the details of which are to be worked out by a special commission previous to the beginning of the experiments.

(2) The cost of each individual experiment is to be borne by the State or society under the auspices of which it is conducted. There is to be no centralization of funds for this purpose.

(3) The experiments are to commence in the spring of 1892 and continue for 4 successive years.

(4) A central office is to be established, the duty of which shall be to purchase seeds and fertilizing materials for and at the expense of the individual experimenters; have general supervision of all the experiments; test the tobacco produced as to quality, commercial value, and chemical composition; and to collect data at different stages of each experiment, compile them, and send copies to the coöperators.

(5) The expense of supporting this central office is to be borne by the Potash Syndicate up to 3,300 marks ($825) per year; beyond this the syndicate pays 10 per cent and the balance is to be made up by an assessment of the coöperating States and societies.

(6) Representatives of the States and societies coöperating in these experiments are to meet annually to consider the results already reached and to make any changes in the general plan which these results may seem to warrant.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING MARCH, 1892.

DIVISION OF STATISTICS:

Report No. 93 (new series), March, 1892.—Distribution and Consumption of Corn and Wheat; Freight Rates of Transportation Companies.

DIVISION OF FORESTRY:

Bulletin No. 6.—Timber Physics.

Circular No. 7.—The Government Timber Tests.

Circular No. 8.—Strength of Boxed or Turpentine Timber.

WEATHER BUREAU:

Monthly Weather Review, December, 1891.

Instructions to Voluntary Observers.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Record, vol. III, No. 8, March, 1892.

Experiment Station Bulletin No. 10.—Meteorological Work for Agricultural Institutions.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING MARCH, 1892.

AGRICULTURAL EXPERIMENT STATION OF THE AGRICULTURAL AND MECHANICAL COLLEGE OF ALABAMA:

Fourth Annual Report, 1891.

Bulletin No. 33, December, 1891.—Cotton.

Bulletin No. 34, January, 1892.—Coöperative Soil Test Experiments.

Bulletin No. 35, January, 1892.—Glanders.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF ARIZONA:

Second Annual Report, 1891.

ARKANSAS AGRICULTURAL EXPERIMENT STATION:

Fourth Annual Report, 1891.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION:

Annual Report, 1891.

GEORGIA EXPERIMENT STATION:

Fourth Annual Report, 1891.

Special Bulletin No. 16½, March 1, 1892.—Announcement Regarding Station Publications.

Bulletin No. 17, March, 1892.—Irish Potatoes; Sweet Potatoes; Tomatoes; Forage Plants.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF ILLINOIS:

Bulletin No. 19, February, 1892.—Experiments with Oats; the Chinch Bug in Illinois.

AGRICULTURAL EXPERIMENT STATION OF INDIANA:

Fourth Annual Report, 1891.

Bulletin No. 38, March, 1892.—Small Fruits; Treatment of Powdery Mildew and Black Rot; Vegetables.

KANSAS AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 26, December, 1891.—A Comparison of Varieties of the Strawberry.

Bulletin No. 27, December, 1891.—Crossed Varieties of Corn.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:

Fourth Annual Report, 1891.

Meteorological Bulletin No. 38, February, 1892.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF MINNESOTA:

Bulletin No. 19, March, 1892.—Dehorning; Cream Raising; Cheese Making; The Babcock Test.

AGRICULTURAL EXPERIMENT STATION OF NEBRASKA:

Fifth Annual Report, 1891.

Bulletin No. 21, March 1, 1892.—Experiments in the Culture of the Sugar Beet in Nebraska.

AGRICULTURAL EXPERIMENT STATION OF NEW MEXICO:

Bulletin No. 5, March, 1892.—Notes on Fruit Insects.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION:

Fourth Annual Report, 1891.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 83, February 19, 1892.—Growing Celery in the South; Cultivation of Onions; Notes on Horticultural Work During 1891.

NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 5, February, 1892.—Sugar Beets.

OHIO AGRICULTURAL EXPERIMENT STATION:

Bulletin vol. IV, No. 10 (second series), December, 1891.—Tenth Annual Report, 1891.

Bulletin vol. V, No. 1 (second series), January, 1892.

OREGON EXPERIMENT STATION:

Bulletin No. 16, February, 1892.—Notes on Varieties and Yield of Wheat.

Bulletin No. 17, February, 1892.—Sugar Beets.

TENNESSEE AGRICULTURAL EXPERIMENT STATION:

Bulletin vol. V, No. 1, January, 1892.—Fruit Trees and Experiments with Vegetables.

WASHINGTON AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 2, January, 1892.—Report of Farmers' Institute held at Colton, Washington.

WEST VIRGINIA AGRICULTURAL EXPERIMENT STATION:

Fourth Annual Report, 1891.

Bulletin No. 20, January, 1892.—Potato Culture and Fertilization; Tests of some Varieties of Tomatoes.

Bulletin No. 21, April, 1892.—Injurious Insects and Plant Diseases.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF WISCONSIN:

Bulletin No. 30, January, 1892.—Sugar Beet Experiments.

WYOMING AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 5, February, 1892.—Best Varieties and Breeds for Wyoming

DOMINION OF CANADA.

ONTARIO AGRICULTURAL COLLEGE EXPERIMENT STATION:

Bulletin No. 71, February 22, 1892.—Experiments with Spring Grains.

Bulletin No. 72, February 29, 1892.—Roots, Potatoes, and Fodder Corn.

U. S. DEPARTMENT OF AGRICULTURE

OFFICE OF EXPERIMENT STATIONS

A. W. HARRIS, DIRECTOR

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EXPERIMENT STATION RECORD.

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EDITORIAL NOTES.

Closely allied to the meteorological problems to which reference was made in the last number of the Record, are the questions relating to the temperature and moisture of the soil. The Maryland Station, in coöperation with this Department and Johns Hopkins University, is conducting soil investigations on a quite extended scale and has already issued an interesting preliminary report. The following suggestive article has been prepared at the request of this Office by Professor Whitney, under whose charge the soil studies of the Maryland Station are being carried on:

The intense activity in agricultural investigations between 1860 and 1870 was nowhere felt more strongly than in the study of the relation of the soil to plant growth. Liebig's generalization of the mineral theory of plant growth had stimulated research into the chemical composition of soils and plants, with a view to explaining the cause of the fertility of agricultural lands.

A large amount of chemical data has been collected, but the investigations have shown that there is no simple relation between the chemical composition of a soil and plant and the fertility of the land, and there seems to be no satisfactory interpretation of the results. For this reason most of our experiment stations are very loath to give the necessary time for the chemical analysis of soils, knowing that the results in most cases will have so little value.

It has long been recognized by practical men, as well as by many of our scientific investigators, that the texture of the soil and the physical relation to moisture and heat have much to do with the distribution and development of crops. Years ago Johnson went so far as to say, in How Crops Feed, p. 216, that "it is a well-recognized fact that next to temperature the water supply is the most influential factor in the product of the crop. Poor soils give good crops in seasons of plentiful and well-distributed rain or when skillfully irrigated, but insufficient moisture in the soil is an evil that no supplies of plant food can neutralize." Storer also, in recording the experiments of others in his

more recent work entitled Agriculture, has much to say of the effect of the physical properties of the soil as related to plant growth, and of the physical effect of fertilizers and manures on the soil. Practically, however, this has been neglected in all of our fertilizer work, and the old theory of fertilization still holds, that soils vary in their power of supplying food to crops and that the chief use of fertilizers is to supply the deficiency of available plant food in the soil.

It is beginning to be realized that sufficient importance has not been given to the physical properties of the soil as a controlling cause in the fertility of the land, and it now appears that the chief value of commercial fertilizers and manures may be in their physical effect on the soil. That the interest in this subject is growing may be seen from the fact that several of the experiment stations have provided for investigations of the physical properties of soils. At the recent conference of the agricultural colleges and experiment stations held in Washington in August, 1891, a resolution was adopted asking that the work of the Weather Bureau "should be enlarged to include the physics, conditions, and changes of agricultural lands."

It may be interesting to outline a general plan upon which these soil investigations should be carried out. The investigations are based upon the following generalizations: The local distribution and development of plants are largely dependent upon the circulation of water within the soil and the ease with which the proper water supply may be maintained within the soil for the crop, and upon the relation of the soil to heat. Soil exhaustion is due to a change in the arrangement of the soil grains, changing the relation of the soil to moisture and heat. The chief value of commercial fertilizers and manures is in their physical effect on the texture of the soil or the arrangement of the soil grains, which changes the relation of the soil to moisture and heat.

The objects of the work are to study the relation of soils to moisture and heat, to find out the conditions which determine the local distribution and development of plants in the great soil formations, and to see how these conditions gradually change in the deterioration of local soils.

Soils should be classified according to their geological origin, and, until some better method is devised, according to their present agricultural value. The latter should not only include the familiar classification into wheat, corn, tobacco, and truck lands, but the natural herbage should also be determined, as showing what conditions prevail in the soil best adapted to the needs of a particular class of plants. A better system of classification can probably be worked out later from the mechanical analysis of the soils, and a few general types be established for comparison with soils of local value.

Localities fairly representing the normal conditions in these type soils should be carefully selected for the investigation of the conditions of moisture and heat peculiar to the great soil formations. Records

should be kept of the temperature and of the amount of moisture in the soil of these different formations, and of the loss of heat from radiation and evaporation. The observations should be taken in connection with the ordinary meteorological observations of an observing station. The work should be comparative so that deductions may be made from the observations. It is not sufficient, for example, that observations be taken in a soil well suited to tobacco, but they should also be taken in a soil near by, where the conditions are known to be unfavorable for the growth or proper development of the tobacco plant.

A method is needed for the determination of the moisture in the soil without removing the sample from the field, as will be referred to later, and the ordinary form of soil thermometers needs to be improved upon. These records should show the actual conditions of moisture and heat within the soil, for, as we see in greenhouse culture, these conditions largely determine the development of plants. Such observations have shown plainly the cause of the local distribution of cotton and tobacco in some of the Southern States.

The relation of soils to heat is so dependent upon the moisture of the soil that it is difficult to give a true interpretation of soil temperatures or to show their relation to plant development unless accompanied with a record of the soil moisture. The relation of soils to water should be carefully studied in the laboratory and in pot experiments. Samples of the soils should be taken with care for laboratory work, and for pot experiments to confirm the laboratory results.

The laboratory work should be based upon the mechanical analysis of the soil, as this should show the texture of the soil. The method of mechanical analysis should be further perfected so that more separations could be conveniently made, especially of the very smallest-sized grains of sand and clay. The clay group has an important value, due to the extremely small size of the grains. There should be a uniform scale of separations for the comparison of soils from different localities.

The relation of soils to water resolves itself into two lines of investigation, the forces which move the water and the conditions which determine the relative rate of flow.

The forces which move the water within the soil are gravity and the tension or contracting power of the exposed water surface. The approximate extent of the water surface can be calculated from the mechanical analysis of the soil. The surface tension and the effect of manures and fertilizers on the surface tension can be found by the ordinary method of the rise of liquids in capillary tubes, using as a solvent pure water or extracts of the soil, representing as nearly as possible the ordinary soil moisture. What little data we have show that the different fertilizing materials have a very marked effect on this pulling power of water. The same class of substances may differ widely in their effect. Kainit, for instance, increases the surface tension of pure water, but

nitrate of potash lowers it very considerably. This opens up an interesting line of investigation.

The relative rate of circulation of water within the soil depends upon the amount of empty space in the soil; the number of grains per gram, showing the extent of subdivision of this empty space; the arrangement of the soil grains; and the influence of the organic matter.

The amount of empty space may be calculated from the weight of a known volume of soil (conveniently taken with an iron cylinder of known capacity driven into the ground) and the specific gravity of the soil itself. The approximate number of grains of sand and clay per gram of soil can be calculated from the mechanical analysis.

It has been suggested that the relative rate with which water circulates within the soil can be calculated from the per cent of empty space, and the approximate number of grains per gram if the grains are assumed to have a mean symmetrical arrangement in each soil and the influence of the organic matter is neglected. The difference between the observed rate of flow determined experimentally and that calculated from the mechanical analysis of the soil should give an idea of the arrangement of the soil grains, if the influence of the organic matter is assumed to be the same in both soils. For example, a tight, almost impervious pottery clay has been shown to have no more clay (45 per cent) than the subsoil of a fertile grass land in a limestone formation. The relative rate of circulation calculated from the mechanical analyses of these two materials would be about the same, but a quantity of water passing through a given depth of the limestone subsoil in one hundred minutes would require several days to pass through the impervious pottery clay. The difference in the rate of movement, in this case, would be due to the difference in arrangement of the soil grains. The influence of the amount and condition of the organic matter on the rate of flow should form a separate line of investigation.

To determine the actual rate of circulation of water in the soil or subsoil in its natural position in a field, a hole should be dug and the soil and subsoil on one side removed to the depth at which the observations are to be made. A column of the soil or subsoil, 2 or more inches square and 4 or 5 inches deep, is then to be carved out, and a glass or metal frame a little larger than this and 3 or 4 inches deep is slipped over the column and melted paraffin is then run in to fill up the space between the soil and the frame. The soil is then struck off even with the top and bottom of the frame, a piece of linen tied over the under side, or, what is better, the frame can rest on some coarse sand or gravel contained in a funnel, to prevent the soil from falling out and to provide good drainage. A section of the frame can then be placed on the top and secured by a wide rubber band or otherwise, and the time noted which is required for a quantity of water to pass through the saturated soil. The initial depth of water over the soil must be the same in all the experiments. The per cent of empty space must of course

be determined in this or in similar samples taken from the field. Similar work can be done on samples of soil and subsoil brought from a distance and loaded into tubes, but the changes due to the drying out of the soil and the difficulties of loading the soil into the tubes are such as to make the method unsatisfactory for comparing soils from different localities. Eight-inch argand lamp chimneys with linen tied over one end may be conveniently used as soil tubes.

The effect of fertilizers on the texture of soils opens up a wide field of investigation. The effect on the surface tension or contracting power of the soil moisture has already been referred to, but there is also a more permanent effect of the fertilizers on the arrangement of the soil grains through flocculation or the reverse, by which the rate of circulation of water within the soil may be very greatly modified. Experiments could be very conveniently carried on in tubes or pots, noting from time to time the effect of the fertilizers on the evaporation from the soil or on the time it takes a quantity of water to pass through the saturated material. The per cent of empty space in the soil must be given in all cases.

A method is here given for the determination of the actual rate of circulation of water in the soil in its natural position in the field, and it has been suggested that a relative rate of circulation can be calculated from the mechanical analysis. The difference between the observed rate and the calculated rate of circulation as compared with the type soil, will show the difference in the arrangement of the soil grains and in the amount or influence of the organic matter. If a soil is thus shown to be either more open or closer in texture than the type soil, then the class of fertilizers best suited to the improvement of this local soil will be indicated. Actual pot experiments, with or without plants, can be made to confirm this and to show that these conditions in the soil can be so changed as to adapt them to the need of a particular crop.

A convenient method is needed for the determination of the moisture in the soil in its natural position in the field, as part of the ordinary meteorological observations of an observing station. The ordinary gravimetric method of determining the moisture in a sample of soil removed from the field is too inconvenient, and the results are not strictly comparable, as different samples of the soil have to be used for each determination.

Several methods have been proposed for determining the amount of moisture in the soil without removing the sample from the field. A method based on the change of electrical resistance of the soil with changing moisture content gives promise of good results if good contact can be secured between the soil and the plates. The method consists of burying plates of carbon or of some other good conducting material in the soil at such distances apart that the electrical resistance of the intervening soil will be about 1,000 ohms when the soil

has about 8 or 10 per cent of moisture. An electric current from an induction coil is sent across from one plate to the other, and the resistance of the soil measured by a Wheatstone bridge arrangement with a telephone instead of a galvanometer. The drier the soil the higher will be the resistance. The soil appears to move away from the plates, however, and the resistance gradually increases from this cause. The movement of the soil grains seems to depend upon the barometric pressure, changing temperature, and changing moisture content of the soil.

This offers two interesting lines of investigation: (1) To perfect this or some other method for the determination of the moisture in the soil without removing the sample from its natural position in the field, and to investigate this movement of the soil grains to see whether it is due to the substance of the foreign body or whether it is simply due to the form of the surface, or whether it is independent of the presence of the foreign substance; (2) to study the relation to the meteorological conditions of atmospheric pressure, changing temperature, and moisture content of the soil. It would seem that this must have an important bearing on the development of roots in the soil.

The relation of soils to heat is largely dependent upon the relation of soils to moisture and the amount of moisture contained in the soil. It takes more heat to raise the temperature of a pound of water one degree than to raise the temperature of a pound of soil the same amount; so that the more moisture there is in a soil the more material there is to be heated, and this added material is harder to heat than the substance of the soil itself.

The temperature of the soil will depend also upon the amount of evaporation from the soil. It has been shown that from this cause alone the temperature of a sandy soil may be much cooler at midday than the temperature of a clay soil. If the soils had been dry this would have been just the reverse, as the substance of the clay is harder to heat than the substance of the sand.

These matters should be considered in all soil temperature work, as this effect of moisture on the temperature of the soil must have an important effect on the development of plants. It shows the necessity also of comparative work.

It has been shown that the mean temperature of a sandy soil is lower than that of an adjacent clay soil, while the sandy soil is drier than the clay soil. These are conditions of a lower temperature and a drier soil, which are used in greenhouse culture to force the ripening of a plant; while the higher temperature and the greater moisture content of the clay soil are conditions used in greenhouse culture to produce a leafy development and to retard the ripening of a plant.

The field of investigation thus outlined appears very important and full of promise of results of great practical value to agriculture. The work as a whole should be systematically arranged and carried out, but there are many different problems which could be taken up and

worked out by themselves. Coöperation between different States and different stations would be very desirable, for the work should be applied to as many soil formations as possible.

In an article on page 672 of this number of the Record, Professor Atwater calls attention to the deficiency of protein in our agricultural products, and shows how this tends to increase the already too great proportions of fat and of carbohydrates in the food which we eat. As regards the crops grown in this country, two improvements are suggested: One consists in the diversification of our agriculture by substituting for a part of the corn now grown other crops which are relatively rich in nitrogen; chief among these are clover, cowpeas, and other leguminous plants. This will not only produce a better balanced ration for live stock, but also help to increase the productiveness of our worn-out soils and keep up the fertility of our newer lands.

But special emphasis is laid on another phase of our agricultural production. By a comparison of analyses of grasses grown in the United States with those of the same species grown in Europe, it is indicated that the former do not contain as much nitrogen as the latter. There is also evidence that our grain crops have a relatively small nitrogen content. This would show a tendency in the development of our cereals and forage plants which is greatly to be deplored, especially in view of the fact that corn, our greatest crop, is poor in nitrogen at best. The conditions which may have produced this decrease in the nitrogen content of our crops are not well understood, but it is more than probable that it is due in large part to careless methods of cultivation, to improper rotation of crops, to the injudicious application of fertilizers, and perhaps especially to the insufficient use of green manures. With a view to finding out the facts regarding the degeneracy of our grains and grasses and to obtaining better varieties than those now grown, it is suggested to import European varieties especially rich in nitrogen, and make experiments with them at stations in different parts of the country. It will be desirable not only to test the adaptability of the European varieties to the conditions prevailing in this country, but also to find out how our own standard varieties can be improved by selection and cross-fertilization. Culture and fertilizer experiments should be made in connection with the work on varieties. Many more analyses of our products are also needed to determine how far those already made truly represent the composition of our crops in different localities and under different climatic and culture conditions.

To encourage work in this line this Department proposes to import the seed of grasses now grown in Germany and to distribute it to such of the stations as are prepared to undertake the investigation of this interesting and important problem.

AN ERROR IN OUR AGRICULTURAL PRODUCTION AND THE REMEDY.

If the data at hand are to be taken as representative, our national dietary and our agricultural production are out of balance. Our crops, our food supply, and the food we consume contain, when taken together, too little of the materials which make muscle and tendon and too much of those which serve the body for fuel to furnish heat and muscular force; that is to say, they lack protein and have an excess of fats and carbohydrates. This is an economic error of grave import. The farmer is primarily responsible. He is the first loser and he must take the first step towards reform. That step will be the producing of plants richer in protein and meats, with more lean and less fat. For the accurate diagnosis of the evil and the successful application of the remedy the stations have rendered and can render invaluable aid.

The trouble has been more or less vaguely felt, but the exact difficulty has not been generally understood. Some late studies of dietaries by the writer help to bring out the error in our food consumption. The compilation of analyses of American feeding stuffs by Messrs. Jenkins and Winton, lately published in the Experiment Station Record (vol. II, p. 701), shows the deficiency of protein in our feeding stuffs.

Much more inquiry is needed to justify definite and final conclusions, but the facts at hand all point so clearly to a one-sidedness of both our food consumption and our food production as to leave little doubt of the facts, though we must look to future inquiry for their exact measure.

ONE-SIDEDNESS OF OUR DIETARY.

Bulletin No. 7 of the Connecticut Storrs Station (see Experiment Station Record, vol. III, p. 213) contains accounts of the composition of materials used for food in the United States, as shown by analyses, and of the quantities of nutrients in a considerable number of American dietaries. The food materials of which analyses are available are mostly from the Northern and Eastern States. The statistics of dietaries summarize the results of investigations by the writer and gentlemen associated with him of 27 dietaries of nearly 900 people, mostly wage-workers in Massachusetts and Connecticut, and of some 13 dietaries of wage-workers in Canada. For the statistics of the composition of the food materials, reference must be made to the original article. The details of the New England dietaries are summarized in Table I, herewith. The same table includes, for the sake of comparison, a number of representative European dietaries and figures for dietary standards.

TABLE I.—*American and European dietaries and dietary standards.*

[Quantities per man per day.]

Reference numbers.	Dietaries.	Nutrients. Protein.	Fats.	Carbohydrates.	Potential energy.	Nutritive ratio.
	AMERICAN (MASSACHUSETTS AND CONNECTICUT).	*Grm.*	*Grm.*	*Grm.*	*Cal.*	*1:*
1	Family of glass blowers in East Cambridge, Mass	95	132	481	3,590	8.2
2	Boarding house, Lowell, Mass.; boarders operatives in cotton mills	132	200	549	4,650	7.6
3a	Boarding house, Middletown, Conn.; well paid machinists, etc., at moderate work: Food purchased	126	188	426	4,010	6.8
3b	Boarding house, Middletown, Conn.; well paid machinists, etc., at moderate work: Food eaten	103	152	402	3,490	7.3
4	Blacksmiths, Lowell, at hard work	200	304	795	6,905	7.4
5	Brickmakers, Mass.; 237 persons at very severe work	180	365	1,150	8,850	11.0
6	Mechanics, etc., in Massachusetts and Connecticut; average of 4 dietaries of mechanics at severe work (not including No. 5)	215	296	749	6,705	6.6
7	Average of 20 dietaries of wage-workers in Massachusetts and Connecticut	152	225	625	5,275	7.5
8	Average of 5 dietaries of professional men and college students in Middletown, Conn.: Food purchased	133	163	508	4,140	6.6
	Food eaten	126	152	489	3,925	6.6
	EUROPEAN (ENGLISH, GERMAN, DANISH, AND SWEDISH).					
9	Well-fed tailors, England, Playfair	131	39	525	3,055	4.7
10	Hard-worked weavers, England, Playfair	151	43	622	3,570	4.8
11	Blacksmiths at active labor, Playfair	176	71	667	4,115	4.7
12	Mechanic, Munich, 60 years old, in comfortable circumstances, light work, Forster	117	68	345	2,525	4.3
13	Well-paid mechanics, Munich, Voit	151	54	479	3,085	4.0
14	Carpenters, coopers, locksmiths, Bavaria; average of 11 dietaries	122	34	570	3,150	5.3
15	Miners at severe work, Prussia, Steinheil	133	113	634	4,195	6.7
16	Brickmakers (Italians), Munich, diet mainly maize meal and cheese, severe work	167	117	675	4,540	5.6
17	German army ration, peace footing	114	39	480	2,800	5.0
18	German army ordinary ration, war footing	134	58	489	3,095	4.6
19	German army extraordinary ration in war	192	45	678	3,985	4.1
20	University professor, Munich; very little exercise	100	100	240	2,325	4.7
21	Lawyer, Munich, Forster	80	125	222	2,400	6.3
22	Physician, Munich, Forster	127	89	362	2,830	4.4
23	Physician, Copenhagen, Jürgesen	135	140	239	2,835	4.1
24	Average of 7 dietaries of professional men and students	114	111	285	2,670	4.7
	DIETARY STANDARDS.					
25	Adult in full health, Playfair	119	51	531	3,140	5.5
26	Active laborers, Playfair	156	71	568	3,630	4.7
27	Man at moderate work, Moleschott	130	40	550	3,160	4.9
28	Man at moderate work, Wolff	125	35	540	3,030	4.9
29	Man at moderate work, Voit	118	56	500	3,055	5.3
30	Man at hard work, Voit	145	100	450	3,370	4.7
31	Man with moderate muscular work, Atwater	125	125	450	3,520	5.9
32	Man with active muscular work, Atwater	150	150	500	4,060	5.6
33	Man at severe muscular work, Atwater	175	250	650	5,705	6.9
34	Man at very severe muscular work, Atwater	200	350	800	7,355	7.9

For the computations of potential energy in the table the estimates of Rubner are used, which assume 4.1 Calories for each gram of protein and carbohydrates and 9.3 Calories per gram of fat. For the estimate of nutritive ratios, one part by weight of fat is taken as equal to two and one fourth of carbohydrates.

The American dietaries in the table selected from the whole number examined are intended to show the range of variation and the averages. The quantities of nutrients are those in the food purchased, unless otherwise indicated. No. 2 is the average of 7 dietaries of families and large boarding houses in Lowell, Lawrence, Lynn, Holyoke, and Boston,

Massachusetts. The majority of the people were operatives in cotton mills, but some were mechanics, clerks, dressmakers, and persons in other occupations. Most of the people in Nos. 2 and 6 belonged to what would be regarded as the lower rather than the higher grades of wage-workers, in respect to quality of work and amount of earnings. No. 3, on the other hand, was the dietary of mechanics above the average grade in respect to work, wages, intelligence, and plane of living. Nos. 4 and 5 represent the food of men at heavy manual work. No. 1 was the smallest and No. 5 the largest of the 21 dietaries of working people examined. As the work of the men of No. 5 was unusually trying, and it was thought that the food consumption might be exceptionally large, it was not included in the averages of No. 6. The number of wage-workers whose food consumption is here set forth is considerable, and the range of wages, character of work, and scale of living are reasonably wide.

The European figures are selected from a number collated from various sources and are intended to illustrate the diet of people with incomes sufficient for good maintenance as estimated by the standards of living in the countries mentioned.

In comparing the American and European figures in the table it is noticeable that the total quantities of nutritive materials are larger, the quantities of carbohydrates and especially of fats are considerably larger, and the nutritive ratios are much wider in the American dietaries than in the European dietaries and standards. This is noticeably the case in the comparison between the dietaries of professional men and students and is also true in a marked degree in those of wage-workers. The nutritive ratios in the European dietaries and standards range from approximately 4.5 to 5.5, while in the American they range from 6.6 to 8 and over.

The object of the statistics of the table is to show that our dietaries are one-sided—that the food contains excess of carbohydrates and especially of fats. If the European dietaries and standards are to be taken as the measure of the needs for nourishment, the American dietaries here cited are decidedly ill-balanced. Are the European dietaries well balanced and are the standards correct?

The European dietaries above cited represent the food consumed by people believed by physiologists and other experts in this branch of science to be well nourished. Unfortunately the food of a large part of the population of Europe is much below the grade here represented. The European standards are believed by the same authorities to represent average requirements for ample nourishment. My reason for proposing dietary standards with larger quantities of protein and energy is that people in this country live more intensely and work harder, and hence may be presumed to need more food. The relative proportion of protein is smaller and that of fats is much larger; in other words the nutritive ratios are considerably wider in the standards proposed by

myself than in any of the European standards. The wider ratios are a concession to the eating habits represented in the American dietaries. I seriously question how far the concession is justifiable. Certainly the German standards agree very closely with the teachings of carefully observed experience and with the results of the best experimental inquiry regarding the nutrition of man, and they are fully in accord with the latest and best investigation of the nutrition of domestic animals, which has been much more thoroughly studied than the nutrition of man. The only argument in favor of large amounts of fuel material and wide nutritive ratios in the American dietaries is that they represent the food of people who eat what they want and all they want; that, in other words, the dietaries are natural ones. But the same is true of the dietaries of well-to-do people in Europe who have so much less of fuel material and yet are well nourished. The quantities of fat in the European dietaries range from 1 to 5 ounces per day, while in the American the range is from 4 to 16 ounces. In the daily food of the well-to-do professional men in Germany, who are amply nourished, the quantity of fat is from 3 to 4.5 ounces per day, while in the dietaries of Americans in similar conditions of life it ranges from 5 to 7.5 ounces. The quantities of carbohydrates in the European dietaries range from 9 to 24 ounces, while in corresponding American dietaries they are from 24 to 60 ounces. People in this country eat what is set before them, asking no questions for economy's sake, provided it suits their taste. We are a generation of fat and sugar eaters. The simplest explanation of this fact is the abundance and toothsomeness of foods containing fat and sugar. Without doubt a very considerable proportion of fat in the American dietaries here examined should be deducted in order to get at the amounts actually eaten. If any one doubts this let him observe how much fat of meat is left with the butchers and how much of that which is cooked and served upon the table is left on the plates, to be sold to the soap men or thrown into the garbage.

It may be urged that people in our Northern States need a larger amount of fuel in their food on account of our rigorous winters. To this there are three objections. The actual difference in temperature between those regions for which the European estimates are made and the northern part of the United States is not great. Even if our winters are slightly colder, we spend our time in well-warmed houses and are warmly clad, so that the actual difference in exposure is far less than the difference in temperature. And finally, the differences in demand for food fuel for warming the body in regions of different temperatures are not so large as is often supposed.

Summary.—The American dietaries here reported contain much larger proportions of fuel material than the best evidence implies to be appropriate. This one-sidedness is manifested in the large quantities of fat and in the wide nutritive ratios. Allowing that the food consumption here exhibited is approximately representative of that of people in the United States generally, our national dietary is decidedly out of balance.

ONE-SIDEDNESS OF OUR AGRICULTURAL PRODUCTION.

Our agricultural production is out of balance. Our national dietary is in the same condition. Our animal and vegetable food products taken together lack protein and have an excess of fats, starch, and sugar. The reasons for this are simple enough when we understand them.

In the first place our vegetable products are deficient in protein. Corn, our great staple, is poor in protein at best. From careless culture and insufficient manuring our grasses, grains, and other crops contain much lower proportions of nitrogen than they ought to and much less than the same crops do in Europe, where farming is more thoroughly done.

It would be an interesting and valuable study to compare the quantities of nitrogen in plants grown in different places under different conditions of manuring and culture. Unquestionably one result would be to show that the percentage of protein in many if not all our more important grasses, forage plants, grains, and perhaps other crops increases with good culture and abundant manuring. The illustrations of this general fact are manifold, though much inquiry will be needed before we shall know just how to formulate it.

In the better-cultivated parts of Europe much larger crops are generally grown than is usual with us. The statistics at hand imply that the grasses and forage crops at least are much richer in nitrogen. In the following table are given the average percentages of protein in three common species of grasses and in red clover.

TABLE II.—*Comparison of proportions of protein in American and European grasses and clover.*

Species.	American.		European.	
	Specimens analyzed.	Protein in water-free substance.	Specimens analyzed.	Protein in water-free substance.
		Per cent.		*Per cent.*
Timothy (*Phleum pratense*)	56	8.0	7	11.8
Orchard grass (*Dactylis glomerata*)	4	9.6	7	14.9
Blue grass (*Poa pratensis*)	18	11.8	6	11.6
Red clover (*Trifolium pratense*):				
Pasture			18	25.5
In bud	2	17.8	11	20.5
Early in blossom			19	17.9
Full blossom	5	15.7	46	16.1
Nearly ripe	4	14.2	4	16.7

The American figures are from the compilation of American analyses by Messrs. Jenkins and Winton, above mentioned. The European are from Dietrich and König's *Zusammensetzung und Verdaulichkeit der Futtermittel* (second edition, 1891). In averages of analyses collated from such widely diverse sources it would be wrong to expect regularity, but taken together they show a most noteworthy advantage of the

European products as compared with the American. The data at hand do not suffice for satisfactory comparisons of other grasses and legumes. Those for wheat show a preponderance of nitrogen in that from the better-cultivated regions of continental Europe as compared with that from the United States. The comparative averages for the other grains, of which the number of analyses is smaller, are irregular.

It looks very much as though we have by careless culture and insufficient manuring of our grasses and other forage crops, if not our grains, for years been gradually breeding varieties poor in nitrogen, while in Europe the opposite course has been pursued. Certain it is that our grasses often contain smaller percentages of protein than are found in the best qualities of cornstalks, and even straw.

Nor has the chemist alone noticed the difference in feeding value of these products. It has long been understood by practical farmers. Mr. James Wood, president of the New York State Agricultural Society, informs me that he has found the statistics of the quantities of hay required in the Eastern States and in England for the production of a given amount of milk or meat to show a very considerable difference in favor of the English hay. Part of the difference may be due to better animals and feeding, but part must be due to better food.

The value of nitrogenous feeding stuffs is only gradually coming to be appreciated, but the progress of exact experimenting brings it out more and more clearly. Thus the experiments on the effects of fodder upon the production of milk, lately made in some of our stations, emphasize the value of narrow rations. Similar and more striking results have been found in an extended series of experiments in feeding cows for milk and steers for beef conducted under the auspices of the Halle Experiment Station (see Experiment Station Record, vol. III, pp. 557 and 640). Even with coarse foods of good quality—hay, clover, and straw—very large proportions of concentrated nitrogenous foods were found advantageous. More protein and narrower rations than those of Wolff's standards were found most profitable.

In the second place, our meats, upon which we depend to supply the protein which our vegetable foods lack, are excessively fat. This fact, which is well understood in a general way, is made very clear by chemical analysis. Thus in König's* compilation of the analyses of beef the average of the European analyses (French, German, and Austrian) for "medium-fat beef" gives 5.4 per cent of fat. The average of a series of analyses of Chicago beef,† such as was said to be of medium fatness, was not far from 27 per cent. A few of the analyses which gave this average were reported some time ago and are incorporated by König with those of very fat beef, for which his average is 29.3 per cent of fat.

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* Chemie der menschlichen Nahrungs- und Genussmittel, dritte Auflage, B. 1, 187.

† These with others are detailed in the Report of the Connecticut Storrs Station for 1891.

In an experiment on the effects of different food material in nutrition, lean beef is often used to supply protein. In the physiological laboratory of the University of Munich, where more work of this kind has been done than anywhere else, many analyses of such beef have been made. The method consists simply in taking the ordinary beef as sold in the market and trimming out the visible particles of fat as thoroughly as possible; the lean thus remaining is found to contain on the average about nine tenths of 1 per cent of fat. Voit found this percentage so constant that he felt warranted in assuming this figure for the quantity of fat in the lean muscular tissue of beef used in exact physio logical experiments. A number of specimens of beef were obtained in Middletown, Connecticut, and prepared in exactly the same way, the writer's experience in Voit's laboratory being used in preparing the specimens in his own. They gave proportions of fat ranging from 2 to 3.6 per cent. An interesting fact brought out by the analyses last referred to and others of similar character made in Connecticut in the same series of investigations, is the mutual replacement of fat and water in muscular tissues. Leaving out of account the fat which is visible to the eye, the remainder (that which is in microscopic particles) seems to take the place of water within the tissue much as shot dropped in a glass filled with water will drive out their volume of water from the vessel. This helps to explain why it is that the quantity of fat in meat may be much larger than appears to the eye. The excessive fatness of our meats results in part from the composition of the material from which the meat is made, for animals fattened on products poor in protein and rich in carbohydrates and fats tend to excessive fatness. It is also due in part to the fact that we have a great excess of soil product in the valleys of the Ohio and Misissippi and on the ranches of the West, and the natural tendency is to condense as much of it as possible into meat.

The manufacture of meat is a process of transforming the vegetable protein, carbohydrates, and fats of grass and grain into the animal protein and fat of beef, mutton, and pork. In the normal growth of the young animal to maturity, a considerable portion of muscle, tendon, and other tissue, of which protein is the basis, is formed from the protein of the food, but in the process of fattening it is chiefly fat which is made from the food and stored in the body. As the animal becomes fatter relatively less protein is formed and the material stored becomes more and more exclusively fat. At present the swine grower and the ranchman convert a large part of the soil product of the country into the fat of pork and beef. The European feeder can not afford this extravagance. His soil product is too precious. His feeding stuffs are richer in protein than the grasses and grain of the Central and Eastern States. He makes tender, juicy beef, of excellent flavor, without excess of fats. People there do not call for the lean of overfattened meat and reject the fat as they do here. When the cattle he is fattening have been

fed to the point where the quantity of fat in the meat is reasonable and the flavor acceptable, they are slaughtered. For him to keep on feeding them and transform a large amount of the protein, fats, and carbohydrates of his feeding stuffs into a relatively small amount of extra fat in the meat would be ruinous to the profit of his feeding.

The excessive production of fat in our meats is uneconomical in several ways. A large amount of vegetable material is required to make a small amount of fat, protein is lost in the process, and the fat thus produced is sold in a market relatively overstocked with fat.

The pork producers of the great corn-growing States select the breeds of swine which, as they say, "will take the most corn to market," and have thus got into the way of growing animals that are, to use a common expression "little else than masses of fat."

The success which swine breeders have attained in producing animals especially fitted for fattening is opposed to true economy. What is needed is to save our protein and produce less fat and carbohydrates. But the hog as bred for fattening is an organism with a phenomenal capacity for consuming protein and carbohydrates and producing fats.

Concerning the bad economy of our pork making, it may be permitted to repeat here what I have said in another place.*

> The pork producer in this country has come to be essentially a manufacturer of fat. Like other manufacturers he must compete in the markets of the world, home and foreign. He meets serious competition in the fat of other meats, in cotton-seed oil, in sugar, and in petroleum. The home market is relatively overstocked with fat pork. * * *
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> There are, then, two things for the pork producer to do: Make leaner pork and get better access to foreign markets. Leaner pork can be obtained by the use of nitrogenous foods, skim milk, bran, shorts, cotton-seed meal if it can be advantageously utilized, beans, peas, clover, alfalfa, and other leguminous plants. It is, however, impracticable for many pork producers to change their system of feeding at once. The bulk of the pork of the country is and for some time must be manufactured from corn, but where nitrogenous foods are available they should be used, and where they are not available an attempt should be made to introduce them. Here is a strong reason for experiments with leguminous forage plants; besides helping to make leaner pork they have the advantage that with them poor hay, straw, and cornstalks can be utilized and that they make rich manure.
>
> To facilitate access to foreign markets, the facts regarding the need and value of our American products must be brought out clearly. Of course this will require much research. The process must be slow and no one can positively predict the results. But it is at any rate safe to say that the facts now at hand are such as to promise an argument of the strongest character.

There is here a suggestion for dairymen in the Eastern States. Skim milk is richer in protein and on that account is excellent not simply for making pork, but making the lean pork that a rational diet calls for in place of the excessively fat product with which the market is flooded.

The service which a number of our stations have rendered in calling attention to the fact that our overfat pork is made by excess of

* Annual Report of the Secretary of Agriculture, 1889, p. 519.

carbohydrates and that it can be made leaner by feeding more protein, is of incalculable value. But there is the same trouble with our other meats. Our beef and mutton are fatter than need be and the excess of fat is greater than we realize.

There is, it is true, a large demand for fat beef. This is because such beef is tender, juicy, and attractive in flavor, and it is not the fat but the lean part of the meat that is mostly wanted. Perhaps it would be going too far to say that by proper feeding just as palatable meat with less fat could be produced in this country. But such meat is produced, as travelers on the continent of Europe have occasion to observe. It would certainly be a useful enterprise for our experiment stations to investigate whether and how leaner beef with the desired texture and flavor may be produced.

We see the masses of what we call fat in meat, but it requires the microscope and chemical analysis to reveal the suprisingly large amounts in the clear, red muscular tissue which we call lean. The feeder who makes use of the nutrition machinery of his cattle to manufacture the lean and fat of meat from grass and grain, instead of stopping when the formation of protein is practically complete and a reasonable amount of fat has been produced, keeps on feeding, and is satisfied because his animals continue to increase in weight and he can get a good price for highly fattened beef. With the taste for beef and the price which such meat brings as they are, he may for the time be justified in doing so. He does not know, however, that in the last stages of the fattening he is drawing water out of the animal's tissue and putting fat in its place, and that as this fat does not increase the animal's weight he gets no pay for it when he sells it.

The consumer of the meat if he be a man with hard muscular work and without enough fuel material in his food otherwise, reaps a benefit from this extra fat, but must pay dearly for it at the prices at which the fatter kinds of beef are sold, for the simple reason that so much material was used to make it. He might much better get the same fuel material in other foods at a fraction of the cost. If he is like many of his fellow workingmen he will not need it, for his other food will supply an abundance and the very fat meat will be simply an expensive luxury. If, on the other hand, he be a man of less active physical exercise, with such a diet as the facts stated in the preceding pages imply that very many if not most of the people of the country in his circumstances live upon, he will have an excess of fat in his diet and will consume part of the excess and reject the rest. Both of the parties to the transaction, producer and consumer, are therefore losers from this abnormal production.

What makes the matter worse is the fact that the fat of meat serves the same purpose in nutrition as butter, sugar, the starch of the grains and of potatoes, and cotton-seed oil, which is becoming an important food product. Nor is this all. Petroleum has largely replaced the

animal fats and oils for purposes of manufacturing and illumination, so that they have scarcely any sale outside the food market, which is so overstocked and in which the competition is so severe.

Indications of the excess of fat in our food products are abundant. We may find them in the quantities of fat of meat which are cut out of the "trimmings" at the butcher shops and in the fat left uneaten on the plates on our tables. In the Report of the Connecticut Storrs Station for 1891, above referred to, a number of cases are cited in which the quantities of fat thus rejected were determined by weighings and analyses.

In a piece of roast beef weighing 16 pounds, the "trimmings," which consisted of the bone and the meat cut out with it and which were left for the butcher to sell to the soap man or get rid of as he might otherwise choose, weighed 4.5 pounds, so that 11.5 pounds of meat went to the consumer, who of course paid for the whole. The 4.5 pounds of "trimmings" consisted of, approximately, 2.25 pounds of bone and 0.5 pound of tendon ("gristle"), which would make a most palatable and nutritious soup, and 1.75 pounds of meat, of which 1 pound was lean and 0.75 pound fat. The customer was so desirous of getting rid of the fat and bone that he did not mind the lean which the butcher in his hurry trimmed out with it. The butcher said that he sold this sort of beef largely to the ordinary people of the city—mechanics, small tradesmen, and laborers; that many of his customers preferred not to take the "trimmings;" and that these were not exceptionally great in this case either in amount or in the ratio of meat to bone for that "cut" of beef, which was the "rib roast." Inquiries of other butchers brought similar information.

One of the dietaries in Table I above is that of well-to-do machinists and other people of moderate incomes in a boarding house in Middletown. One ninth of the whole nutritive material of the food was thrown away with waste from the kitchen and table. One sixth of the whole of the fat was thus left unconsumed and most of this fat came from meat. This wastefulness is not mere perverseness. It is in part at least in obedience to a natural instinct which leads us to reject material which we do not need for nourishment.

The percentages of fats in the American dietaries above detailed, the magnitude of which is so striking when compared with the corresponding percentages in the dietary standards and European dietaries, explain the physiological reason for the rejection of fats in the household and meat shops and the falling off in demand for fat meats in the market at large. These things are the response of the natural instinct to an unnatural usage. They are the protest of nature against an abnormal diet induced by an abnormal agriculture.

In the wise ordering of nature such evils tend to work their own cure. This case is no exception to the rule. There are indications that the taste of consumers is changing. Very fat beef is in less demand than

formerly. The same is true of pork. The English market calls for leaner pork than is made in our great corn-growing States. Pork packers say that their wares find less ready sale in the South than they used to. Butchers in the Eastern States report a falling off in the demand for fat meats. In other words, the surest possible incentive for improvement is being developed in the market demand.

The diagnosis of the difficulty leaves no doubt as to its nature. The method of cure is equally plain.

It is clear that we need to grow feeding stuffs richer in nitrogen than we now have. This can be accomplished by breeding and importing varieties of plants richer in nitrogen and by cultivating more legumes.

Of what may be done to improve by breeding we have abundant illustrations. The increase of sugar in the sugar beet from 10 to nearly 20 per cent is a case in point. The compilation of American analyses referred to above shows the percentage of protein in kernels of dent corn to range from 7.5 to 11.8 and of flint corn from 7 to 13.7.

For the improvement of corn it would seem that what is needed is to select corn with large protein content and otherwise desirable character as to total product, period of growth, hardiness, fitness to local conditions, etc., and by careful breeding obtain varieties rich in protein. In how far this is actually feasible is a question to be settled by experiment. For other grains and for grasses it may be well to import seed of foreign varieties which are already bred up to a high protein content, just as we import seed of the high-bred varieties of sugar beets. Possibly varieties of maize with large protein content might be found in southern Europe where maize matures. Indeed it is not impossible that we might find them at home by careful search. Perhaps, too, we may already have the other grains and grasses of the desired composition. The subject is one which demands thorough investigation. Its importance can hardly be overestimated.

Another means for increasing the protein of our soil products is the cultivation of more leguminous plants, such as clovers, alfalfa, vetch, serradella, cowpeas, peas, and beans. The advantages of this are manifold. The legumes obtain nitrogen from the air. They do not require nitrogenous manures, but where manuring is needed they may be grown with the aid of the less expensive mineral fertilizers. Their large proportion of protein supplies the want of this material for fodder. Mixed with poor hay, straw, and cornstalks they make a fodder equal to the best hay, as is explained by chemistry, demonstrated by exact experiment, and confirmed by wide experience. The nitrogen which is not stored in the body of the animal in the form of lean meat or otherwise, reappears in the excrement and makes rich manure.

By growing legumes, therefore, the farmer gets the protein needed for fodder for his stock and the nitrogen needed for his grasses, grains, and other crops. The advantage in both these respects is greater than farmers generally appreciate. The loss from insufficient protein in the

food in fattening steers and feeding milch cows appears to be greater than has heretofore been supposed. Nitrogen is the most costly ingredient of fertilizers. Farmers in the older States pay millions of dollars every year for nitrogen in nitrate of soda, sulphate of ammonia, dried blood, tankage, guano, and other nitrogenous materials. Surely it is proved conclusively that our common legumes—clovers, alfalfa, cowpea, lupine, etc.—are able to obtain nitrogen from the air, so that by growing them it is clear that the farmer can have nitrogen for nothing instead of purchasing it in artificial fertilizers.

Summary.—The fat of meat, lard, butter, and cotton-seed oil, and the sugar and starch, which constitute the larger part of the nutritive material of wheat and other grains and nearly the whole of that of potatoes, all do the same work in nutrition—they are the fuel of the body. Taking our food production and the demand of the country for nutriment, each as a whole, we have a large excess of the materials which serve as fuel, while the protein compounds which build muscle, tendon, bone, and other tissues are relatively deficient. In consequence the cattle grower, the pork producer, the dairyman, the sugar maker, the raiser of wheat and potatoes, and the cotton planter are competing with each other in an overstocked market.

Meanwhile, there is a relative deficiency of protein in our food production for both man and domestic animals. The farmer needs more protein for food for his cows to make more milk at less cost; for the steers and swine he is fattening for market so as to make more and leaner meat; and for his horses and his oxen so that they will do better and more economical work. The people at large need more protein and less fat and carbohydrates in their food so that they may be nourished in a more healthful way and at less expense.

The needed increase of protein may be obtained by breeding and importing varieties of grains and grasses richer in nitrogen than those we now cultivate and by growing more legumes. The advantage of legumes to the farmer is manifold. They do not require nitrogen from manure but obtain it from the air. They elaborate the nitrogen into protein for fodder. By mixing leguminous products with poor hay, straw, and constalks the large quantities of carbohydrates in the latter can be most profitably utilized. The food thus produced for stock is what is needed to make leaner meat and more of it, and more milk at less cost; the nitrogen not transformed into meat or milk makes rich manure for grasses, grains, and other crops; and finally the richer manure helps to bring crops richer in protein.—[W. O. A.]

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Alabama College Station, Bulletin No. 33, December, 1891 (pp. 12).

EXPERIMENTS WITH COTTON, J. S. NEWMAN AND J. CLAYTON.—These include a test of varieties and experiments with fertilizers. An account of previous experiments was given in Bulletin No. 22 of the station (see Experiment Station Record, vol. II, p. 548).

Test of varieties.—Descriptive notes and tabulated data are given for 28 varieties tested on plats and 8 tested in the field. In connection with the latter experiment a test of the Gullett and Pratt gins was made, which indicated that there was no great difference in the working of these two kinds of gins. Welborn Pet, a "cluster" variety, was planted at distances of from 1 by 4 to 4 by 4 feet, and Peeler, a long-limbed variety, was planted at distances of from 2 by 4 to 4 by 5 feet. The largest yield in both cases was from the planting at the shortest distances.

Experiment with fertilizers.—An experiment with acid phosphate alone and combined with cotton seed meal begun in 1890 was continued in 1891. The yields for both years are stated. In 1890 the two fertilizers combined gave the best results, but in 1891 the results on different plats were conflicting.

Alabama College Station, Bulletin No. 34, January, 1892 (pp. 46).

COÖPERATIVE SOIL TESTS IN 1891.—These were with fertilizers for cotton, and were carried out on 36 farms in different parts of the State. The fertilizers applied were nitrate of soda 96 pounds, acid phosphate or floats 240 pounds each, and muriate of potash 64 pounds, used singly, two by two, and all three together; green cotton seed 848 pounds, used alone or with floats; cotton-seed meal 240 pounds, used with acid phosphate; and stable manure 4,240 pounds, used alone. Each experiment included 16 plats, the size of which is not given. The results of each experiment are tabulated and discussed separately, but no general summary of results is given.

In addition to these experiments reports are given of special nitrogen and potash experiments, intercultural experiments, and a test of 14 varieties of cotton made at one farm in the State. The soil used for the latter experiments was sandy, with clay subsoil.

"Although the experiments are not perfectly accurate, they point to several conclusions with some degree of certainty. Potash does not seem to pay; phosphate applied alone does not have much effect; nitrogenous fertilizers in any form give an increased yield; and only nitrogenous fertilizers increase the yield when applied interculturally."

Alabama College Station, Bulletin No. 35, January, 1892 (pp. 19).

GLANDERS, C. A. CARY.—A popular account of the symptoms, causes, and methods of transmission of different forms of glanders; suggestions regarding preventive treatment: and the text of the State law approved February 28, 1887, "for the prevention and suppression of infectious and contagious diseases of horses and other animals."

Arkansas Station, Bulletin No. 17, October, 1891 (pp. 16).

TESTS OF VARIETIES OF FRUIT, J. F. MCKAY.—Notes are given on grapes, strawberries, raspberries, plums, and pears.

Grapes.—Descriptive notes on 22 varieties. Out of the many varieties tested only a few seemed adapted to Arkansas. Those which are free from disease are derived from *Vitis æstivalis* and *V. cordifolia.* The varieties derived from *V. labrusca* can be successfully grown in this State only by systematic treatment with fungicides. The following varieties are recommended in the order of ripening: Moore Early, Cottage, Eumelan, Delaware or Brilliant, Perkins, Ives, Concord, Eaton, Cynthiana or Norton, Cunningham, and Herbemont.

Strawberries.—Tabulated data are given showing the comparative keeping quality of 27 varieties stored for 7 days in a room the temperature of which ranged from 60° to 80° F. The varieties that kept best were Charleston, Cloud Seedling, Crawford, Hoffman, and Wilson. Descriptive notes are given on 17 of the most promising varieties. The following are recommended for Arkansas: Bubach No. 5, Warfield No. 2, Haverland, Stayman Nos. 1 and 2, Cloud Seedling, Crescent, Crawford, Hoffman, Michel Early, Beder Wood, Van Deman, and Captain Jack.

Raspberries.—Brief descriptive notes on 8 varieties. Marlboro, Hansell, Ohio, and Gregg are especially commended.

Plums.—Brief descriptive notes on 11 varieties.

Pears.—The Le Conte and Keiffer varieties are compared. The latter have suffered less from blight and seem to be the more valuable variety for Arkansas.

California Station, Bulletin No. 96, January 25, 1892 (pp. 8).

SULPHURING IN FRUIT DRYING, E. W. HILGARD, PH. D. (pp. 1, 2).—The author reaffirms his views regarding the harmfulness of sulphuring fruit as stated in Bulletin No. 86 of the station (see Experiment Station

Record, vol. II, p. 98). Experiments with solutions of bisulphite of soda as a substitute for sulphur are in progress at the station.

TESTS OF VARIETIES OF FIG TREES, C. H. SHINN (pp. 3–6).—A list is given of 50 varieties which are being tested at the different substations in California. There are also brief notes on the relative hardiness of a number of these varieties in different parts of the State. Among the varieties which have proved hardy in the different localities are Doree Narbus, White Adriatic, and Du Roi.

PERSIAN PALMS, C. H. SHINN (pp. 7, 8).—Brief notes on the varieties recently planted at Pomona and Tulare, which were imported by this Department. Thus far Seevah seems most promising.

Colorado Station, Bulletin No. 17, October, 1891 (pp. 42).

FRUIT INTERESTS OF COLORADO, C. S. CRANDALL, M. S.—This is a preliminary report on the condition of fruit growing in the State. While this is a comparatively new industry in this region it has a promising outlook and the area devoted to large and small fruits is rapidly increasing. A number of examples are given to show what individual growers in different parts of the State are doing in the culture of various fruits. There is also a preliminary list of the varieties of fruits grown in the State, which includes the following: 277 varieties of apples, 19 of crab apples, 6 of apricots, 10 of blackberries, 7 of currants, 13 of cherries, 6 of gooseberries, 68 of grapes, 15 of peaches, 29 of pears, 3 of prunes, 31 of plums, 1 of quinces, 15 of raspberries, and 31 of strawberries.

Colorado Station, Bulletin No. 18, December, 1891 (pp. 9).

This includes an index to the first seventeen bulletins of the station.

Colorado Station, Special Bulletin A, January, 1892 (pp. 10).

This contains statements regarding the lines of work pursued by the several sections of the station, and suggestions regarding ways in which the correspondents of the station may aid in its work.

Delaware Station, Third Annual Report, 1890 (pp. 176).

FINANCIAL STATEMENT (pp. 4, 5).—This is for the fiscal year ending June 30, 1890.

REPORT OF DIRECTOR, A. T. NEALE, PH. D. (pp. 7–24, figs. 5).—A summary of the work of the station in its several departments. There is also an illustrated description of the extractor used in the experiments with sweet-cream butter, an account of which is given below.

STUDIES OF SOILS AND CROPS TO LEAD IF POSSIBLE TO A MORE RATIONAL AND ECONOMICAL USE OF COMMERCIAL FERTILIZERS, A. T. NEALE, PH. D. (pp. 25–35).—A description of coöperative

experiments reported in Bulletin No. 11 of the station (see Experiment Station Record, vol. II, p. 716).

THE STUDY OF FORAGE AND OTHER SPECIAL-PURPOSE PLANTS, A. T. NEALE, PH. D. (pp. 36–43, fig. 1).—*Scarlet clover* (pp. 36–39).—This plant is briefly described.

It is used in Delaware largely in peach orchards, seed being sown at the last cultivation of the trees. * * *

For seed it is sown on rather poor land; no fertilizers are used. A crop of buckwheat may be put in at the same time to shade the young plants as well as to utilize the ground. Two hundred and seventy bushels of clean seed were actually sold last summer at Milford from 17 acres, representing an average of 16 bushels per acre. Ten bushels per acre is generally regarded as a good crop. Its market value at wholesale was \$5 per bushel. Fifteen pounds is said to be enough to seed an acre, but 1 bushel to 7 acres often satisfies practical farmers. A popular way of raising scarlet clover is to seed corn land late in July, using a Cahoon sower. A fair growth is made after the corn is cut off in the fall. By the first of May blossoms will be seen, and by the fifteenth the crop may be turned under in time for potatoes or a second corn crop. It may be cut and packed into silos for green food. Tests of all these methods have resulted favorably.

A trial was made at the station of seeding this clover between rows of sorghum 32 inches apart, sowing July 20 and August 2, 10, and 20, 1889. The crops were seriously injured by clover canker. They were cut May 12, 1891, when in full bloom, with the following yields of green clover per acre: Seeded July 20, 16,428 pounds; August 2, 17,464 pounds; August 10, 26,566 pounds.

Analysis demonstrated that more than 82.5 per cent of the clover was water; hence, 13 tons, 556 pounds is equivalent to 2 tons 611 pounds of perfectly dry hay. This sample was handled under conditions which excluded all possible loss of leaves, etc., hence its analysis given in detail in the chemist's report indicates a product much higher in value than ordinary red clover hay; its value in fact being equivalent in chemical composition to an average grade of wheat bran.

As to its manurial worth, this much can be said: The green crop, weighing 13 tons, 566 pounds, contained 115 pounds of nitrogen, 131 pounds of potash, and 35 pounds of phosphoric acid. To secure this amount of plant food in the shape of commercial fertilizers would involve an outlay of nearly \$24. * * *

Seventy per cent of the total value is credited to the nitrogen, the element which the clover can take up from the air; 30 per cent is credited to phosphoric acid and potash, elements which must come from the soil alone. In the above estimates it will be noted that no credit whatever is given to the plant food stored in the clover roots, nor can credit be given to the indirect but extremely valuable effects caused by the decomposition of this mass of green matter in the soil. * * *

At least 450 bushels of seed found a market in Delaware last July and August, a quantity, at the usual rate of seeding, sufficient for nearly 3,000 acres. If results are favorable this year it is predicted that this acreage will be doubled in August, 1891.

Sorghum (pp. 39–43).—The results are reported of tests of varieties at Harbeson, Odessa, and the station. At Harbeson 1,638 canes were grown from a single seed head from Rio Grande, New Jersey, believed to be a cross with Early Orange. Seventy-four representative canes were selected for analysis. "As regards sugar, more than one half of

the cane equaled the parent stalk and exceeded it to very marked degree in purity. Another point is that the heavier canes on an average were the better canes. This point was taken as a standard, and in saving seed from the rest of the plat, heads from large, well developed stalks were culled out and cured separately." The Honduras from pedigreed stock grown in Kansas was also tested.

One cane of the Honduras type, cut on October 29, illustrates one of its characteristics. This cane was 16 feet 8 inches tall; its seed top weighed 3 ounces; when stripped and topped the cane itself weighed 4 pounds, 2 ounces. Chemical analysis indicated 9.39 per cent of sugar, 59.8 degrees purity. Efforts at selection from this seed head will be made next year.

[At Odessa Folger Early and an unknown variety from Kansas were tested on half-acre plats.] Tests made of the former, at intervals from September 18 to October 9, indicated a minimum of 11.71 per cent and a maximum of 13.82 per cent of sugar. The average of all tests was 12.76 per cent sugar, 72.4 degrees purity. The second variety tried was Folger Early (Newark seed from Sterling, Kansas, breeding). Tests during the interval from September 18 to October 9 ranged from 11.68 per cent to 13.87 per cent sugar. The average of all tests was 12.69 per cent sugar, 70.8 degrees purity. One variety supplements the other to a certain extent. Folger Early gave its highest tests in September. * * *

[At the station Early Amber, Honduras, Undendebule, Lynk Hybrid, and Folger Early were tested. Analyses are given of canes of each variety at different dates.]

To one accustomed to the low averages common in the commercial attempts to make sorghum sugar, these figures, ranging as a rule between 12 and 14 per cent sugar and from 70 to 80 degrees purity, awaken interest. The fact that the large canes have given the most favorable returns for each variety suggests one cause of past failures, viz, the attempts to gain tonnage of green crop with too little regard for the pounds of sugar to the acre.

[A method of selecting canes for growing seed similar to that practiced in sugar beet culture is suggested.] The pieces between the nodes of a sorghum cane can be crushed and their mixed juices analyzed. If found good the nodes or knots of that cane can be used as mothers are used in the beet industry.

Report of Mycologist, F. D. Chester, M. S. (pp. 44–91, figs. 14).—This includes accounts of experiments in the treatment of (1) diseases of the grape, (2) pear and quince leaf blight, (3) potato rot, (4) bitter rot of the apple; and notes on (1) leaf spot of alfalfa (*Pseudopeziza medicaginis*), (2) rot of scarlet clover (*Sclerotinia trifolium*), (3) scab of wheat (*Fusarium culmorum*), and (4) black rot of the sweet potato (*Ceratocystis fimbriata*).

Treatment of diseases of the grape (pp. 45–69).—An account of spraying experiments with fungicides, reprinted from Bulletin No. 10 of the station (see Experiment Station Record, vol. II, p. 712).

Treatment of pear and quince leaf blight (pp. 69–77).—An account of spraying experiments with fungicides, reprinted from Bulletin No. 13 of the station (see Experiment Station Record, vol. III, p. 144).

Treatment of potato rot (pp. 77, 78).—A brief account of a spraying experiment with Bordeaux mixture on potatoes in a field at Mermaid, Delaware. The applications were made August 19 and September 10, after the disease had begun to show itself in the blighting of the vines.

The sprayed area yielded 200 bushels of sound potatoes per acre, while the unsprayed yielded only 126 bushels.

Treatment of bitter rot of the apple (pp. 78, 79).—A brief account of an experiment in an orchard at Smyrna, Delaware, in which one apple tree was sprayed with sulphide of potassium, and another with commercial carbonate of copper. The former fungicide was partly effective, but the latter seemed to have no effect. The disease had progressed too far before the first application to make the experiment a fair test.

Leaf spot of alfalfa (pp. 79–84).—An illustrated description of *Pseudopeziza medicaginis*, and a brief account of an experiment in which soil from a field where diseased alfalfa was growing was sterilized by heating and planted with alfalfa seed, some of which had been soaked in a solution of copper sulphate. The results were negative.

Rot of scarlet clover (pp. 84–89).—An illustrated description of *Sclerotinia trifolium* observed on a plat of scarlet clover at the station.

Scab of wheat (pp. 89, 90).—A brief illustrated description of *Fusarium culmorum*.

Black rot of sweet potatoes (pp. 90, 91).—Sweet potato plants were grown in four boxes containing soil from a propagating bed in which the black rot (*Cerastocystis fimbriata*) had been previously developed. The soil in two boxes was sterilized by heating. The tubers grown in the unsterilized soil were healthy. In another experiment diseased and healthy tubers were planted in separate boxes containing sterilized soil. Fifty per cent of the tubers grown from diseased seed were diseased, while those grown from healthy seed were all healthy.

REPORT OF HORTICULTURIST, M. H. BECKWITH (pp. 92–109).—This includes a list of the fruits planted in 1890, and accounts of tests of varieties of strawberries and potatoes.

Fruits planted (pp. 93–100).—A list of 76 varieties of peaches planted for experimental purposes in the orchard of S. H. Messick, near Bridgeville, Delaware; 194 varieties of peaches planted in the orchard of C. Wright, near Seaford, Delaware; 37 varieties of peaches planted at the station; and 61 varieties of strawberries, 5 of currants, and 5 of gooseberries planted at the station.

Strawberries, test of varieties (pp. 100–106).—Tabulated data for 22 varieties tested at Newark, Bridgeville, and Mermaid. Bubach, Gandy, and Pearl were among the most promising varieties.

Potatoes, test of varieties (pp. 106–109).—Tabulated data for 52 varieties tested at the station and 8 at Dover, Delaware. At the station the most productive varieties were Crimson Beauty, Delaware, McClelland, Great Eastern, Invincible, and Summit. At Dover, Gandy was superior in yield and quality. The varieties free from rot were Early Maine, Early Ohio, Early Puritan, Lee Favorite, Minister, and Rough Diamond. Among those seriously injured by rot were Crimson Beauty, Gandy, Invincible, and Summit.

REPORT OF ENTOMOLOGIST, M. H. BECKWITH (pp. 110–129, figs. 6).—A reprint of Bulletin No. 12 of the station (see Experiment Station Record, vol. II, p. 718).

REPORT OF CHEMIST, C. L. PENNY, M. A. (pp. 129–154).

Sour-cream process, sweet-cream process, and butter extractor (pp. 129–149).—A reprint of the experiments on these subjects reported in Bulletin No. 9 of the station (see Experiment Station Record, vol. III, p. 602).

Miscellaneous (pp. 149–154).—Brief mention is made of examinations of grapes for copper "to test whether the application of a certain copper mixture to the vines affects the fruit or makes it unsafe for food." A sample of fruit covered with spots of copper giving it "a distinctly and disagreeably metallic taste," was reported to have 47 parts of copper per million, or less than has been reported in some articles of food considered healthy, as beef liver. "In other words, the tongue is a sufficient safeguard against eating fruit that contains this copper salt in poisonous quantities."

To determine the amount of copper absorbed by potatoes when growing in a soil containing it, analyses were made of the skin and pulp of tubers from an unknown source and those grown in a soil rich in copper. The potatoes grown in soil rich in copper contained 1.33 parts of copper per million in the pulp and 40 parts in the skin; and those of unknown origin 1.26 parts in the pulp and only 16 in the skin. "It is interesting to note that while the tubers from copper soil held two and one half times as much of the metal in the rind as the other sample, the inner part held practically the same amount in either case." Analyses are given of a tartar emetic, slug shot, odorless phosphate, parts of corn stover, and scarlet clover; and the composition of the latter is compared with that of wheat bran, as follows:

Scarlet clover compared with wheat bran.

	Scarlet clover.		Average wheat bran.
	Original state.	Hay (air-dry).	
	Per cent.	*Per cent.*	*Per cent.*
Moisture	84.62	10.70	10.70
Crude ash	1.37	7.96	6.00
Crude cellulose	3.46	20.09	8.60
Crude fat	0.83	4.82	4.90
Crude protein	2.73	15.85	14.80
Nitrogen-free extract	6.99	40.58	55.00
	100.00	100.00	100.00

The clover hay contained 2.9 per cent of potash and 0.58 per cent of phosphoric acid.

REPORT OF METEOROLOGIST, G. A. HARTER, M. A. (pp. 154–170).—Tabulated monthly summaries of observations in 1890 at Newark, Middletown, Dover, Milford, Seaford, and Millsborough, Delaware. At the station the mean temperature for the year was 53.7° F., the total rainfall 44.16 inches, the number of days on which 0.01 inch or more of rain fell 114.

Georgia Station, Fourth Annual Report, 1891 (pp. 7).

This includes brief statements regarding the changes in organization, new buildings erected, and experimental work performed during 1891, and a subject list of Bulletins Nos. 10–15 issued during the year. There is also a financial statement for the fiscal year ending June 30, 1891.

Georgia Station, Bulletin No. 16, February, 1892 (pp. 29).

EXPERIMENTS WITH COTTON, R. J. REDDING (pp. 129–157).—This includes experiments with fertilizers and with different methods of culture for cotton, and variety tests.

Special nitrogen experiment (pp. 129–135).—This is a repetition on the same 28 fourteenth-acre plats of a special nitrogen experiment with cotton made in 1890 and reported in Bulletin No. 11 of the station (see Experiment Station Record, vol. II, p. 553). The tabulated data include analyses of the fertilizing ingredients used, the rainfall during 1891 by months, and the yields of cotton at three different pickings. The author summarizes the results as follows:

1. This is a very poor soil, being deficient in all the elements of plant food, but especially in phosphoric acid. A moderate dose of potash (muriate) proved decidedly injurious instead of beneficial.
2. Phosphoric acid in combination with potash gave moderately good results.
3. Nitrogen in the form of nitrate of soda alone was of no material benefit; in the form of cotton-seed meal it gave a considerable increase, probably partly due to its phosphoric acid and potash; as sulphate of ammonia a moderate increase; as dried blood a smaller increase.
4. Nitrogen in every form used, when in combination with phosphoric acid and potash (mixed minerals), gave much the best results and appeared to be the most effective element.
5. Nitrogen seemed most effective when applied (1) in the form of stable manure, (2) in the form of nitrate of soda, (3) in the form of crushed cotton seed, (4) in the form of cotton-seed meal, (5) in the form of dried blood, (6) as sulphate of ammonia.

General fertilizer experiment (pp. 135–144).—An experiment on 102 plats, each 69⅗ feet in length and containing three rows 4 feet apart. Eleven plats remained unfertilized. On the other plats superphosphate 156, 312, and 468 pounds; muriate of potash, 39, 78, and 117 pounds; and nitrate of soda 65, 130, and 195 pounds were variously combined with each other and with 429 pounds of cotton-seed meal per acre. The land had recently been in corn, oats, and peas, and was prepared by turning the pea stubble in with a plow. The variety of cotton used was Truitt Improved. The results are tabulated. The author concludes that—

(1) Phosphoric acid is the most effective in increasing the yield of cotton on this soil.

(2) Potash was not required except when liberal amounts of phosphoric acid and nitrogen were used, when one dose of potash was moderately effective. The behavior of potash (muriate) is uncertain and even erratic, as shown by the absence of uniform results where this element was used in increasing quantities. It is not certain that on the whole potash increased the yield of cotton.

(3) Nitrogen is very effective when used in medium quantities in two doses, in combination with three doses of phosphoric acid. A larger proportion of nitrogen appears to be injurious.

(4) Cotton-seed meal as a source of nitrogen is equally effective with nitrate of soda in the same combinations as plant food for cotton.

(5) The most effective combination of the three elements as a fertilizer for cotton on the soil covered by this experiment is three doses of superphosphate 468 pounds, containing 66 pounds phosphoric acid; two doses of muriate of potash 78 pounds, containing 39 pounds of potash; two doses of nitrate of soda 65 pounds, containing 120 pounds of nitrogen.

Intercultural fertilizing (pp. 144–147).—Two experiments to observe the effect of applying a given amount of fertilizer all at once and in fractions, were made in 1891 during the growing season and were similar to one made in 1890, reported in Bulletin No. 11 of the station (see Experiment Station Record, vol. II, p. 553). One experiment was inconclusive. In the other superphosphate and muriate of potash were used with cotton-seed meal or nitrate of soda, being applied either all before planting, part before planting, or part at planting, and the remainder in two or three fractions later (June 1 and July 1).

(1) Successive or intercultural applications of nitrogen in the form of cotton-seed meal are not profitable. It is more effective when all is applied at or before planting than when applied in two doses, and less effective in three than in two.

(2) Nitrogen in the form of nitrate of soda may be profitably divided into not more than two applications, the second not to be later probably than June 1. It does not appear what would have been the result if one half the nitrate had been applied July 1 instead of June 1.

Topping cotton (pp. 147–149).—A previous experiment on topping cotton was reported in Bulletin No. 11 of the station (see Experiment Station Record, vol. II, p. 554). One acre, containing 52 rows of cotton, all of which were manured and cultivated exactly the same, was used for the experiment in 1891. "Every fifth row, commencing with the first and ending with the fifty-first, was left untopped. On July 1, July 15, and August 15 each 10 rows were topped, each row topped at any of the dates being separated by 5 rows from the nearest row topped at the same date." The yields of cotton for the topped and untopped rows at 5 successive pickings are tabulated.

(1) It is again proved (as last year) that topping produces a material effect on the yield. Both last year and this year topping from July 1 to July 15 injured the yield most. Last year the rows not topped gave the largest yield; this year those topped August 15 gave the largest.

(2) Topping cotton is a hazardous experiment and very uncertain. The probable effect can not be foreseen with sufficient certainty. It is probable that many farmers have topped their cotton and believed the effect was beneficial when in fact careful competitive experiment would have proved the contrary.

It is suggested that the conditions under which topping would be most likely to prove beneficial are when the cotton plants will probably be large—4 or 5 feet high—and have good distance. If crowded in the row topping tends to crowd the foliage still more by causing the branches to grow longer.

Deep vs. shallow culture of cotton (p. 149).—An experiment on 6 plats similar to the one reported in Bulletin No. 11 of the station (see Experiment Station Record, vol. II, p. 554).

"Last year this experiment resulted very favorably to the shallow culture theory; this year less so, and yet decisively, considering the extra cost of deep culture. In other words, so far as this experiment goes it proves that deep culture is not beneficial."

Test of varieties of cotton (pp. 149–151).—Tabulated notes are given for 17 varieties of cotton.

Cotton at different distances (pp. 151–155).—Cotton was planted on 1 acre of land in rows 4 feet wide and afterwards thinned to distances of 1, 2, 3, and 4 feet, respectively, in the rows. The entire acre was manured with 312 pounds of superphosphate, 78 pounds of muriate of potash, and 130 pounds of nitrate of soda, at a cost of $6.99. The yields of cotton at different distances are tabulated. The author's conclusions are as follows:

(1) On land capable of making between 1 and 1.5 bales of cotton per acre the plants should not be closer than 4 by 2 feet, nor wider probably than 4 by 3 feet.

(2) The greater the distance given the more important it is to secure an early stand, thin out early, and give rapid cultivation.

(3) Close planting gives a larger yield in the early fall, or at the first and second pickings. (The 4 by 1 series in the experiment was 161 pounds ahead of the 4 by 2 series at the close of the fourth picking, October 16.) This is because each plant, when planted close, will make nearly if not quite as many blooms in the first few weeks of blooming as each plant in widely planted rows. Between the date of the first and second pickings, a period of 12 days, 1 pound of cotton was yielded by every 15 plants of the 4 by 1 series, while in the 4 by 2 series 12 plants were required to 1 pound. When it is considered that there were only 5,005 plants to the acre in the 4 by 2 series against 9,250 plants in the 4 by 1 series, the explanation of the greater yield of the 4 by 1 series at the second picking is plain. At the fifth picking, November 4, 43 plants in the 4 by 1 series yielded 1 pound, while in the 4 by 2 seies 13 plants only yielded 1 pound.

Effect of different amounts of fertilizers applied to cotton (pp. 155–157).—An acre of land containing 52 rows of cotton was used for this trial. A mixture of 60 pounds superphosphate, 15 pounds muriate of potash, and 25 pounds nitrate of soda per acre was applied to different series of rows in this amount and in two, three, four, five, and six times this amount, respectively. The yields of the series of rows receiving different amounts of fertilizers are tabulated. "Successively increasing amounts of fertilizers do not result in the same ratio of increasing yields of cotton. It follows that the larger the amount of fertilizers the greater will be the resulting cost of the increase per pound, while at the same time there will be left in the soil a correspondingly larger amount of fertilizer for the use of the succeeding crop."

Georgia Station, Bulletin No. 17, March, 1892 (pp. 36).

EXPERIMENTS WITH IRISH POTATOES, SWEET POTATOES, TOMATOES, AND FORAGE PLANTS, G. SPETH (pp. 165–198).

Irish potatoes (pp. 165–174).—The experiments were in continuation of those reported in Bulletin No. 8 of the station (see Experiment Station Record, vol II, p. 324), and included a test of varieties and experiments

in planting at different distances and with different amounts of seed, and in the use of fertilizers. Tabulated data are given for 30 varieties, with some of which the relative merits of Eastern, Western, and Southern seed were compared.

The following tables give the plan and results of the experiments with different methods of planting:

Different quantities of seed planted at different distances.

No. of plat.	Size of seed.	Distance apart.	Seed per acre.	Calculated yield per acre.					
				Early Rose.			Beauty of Hebron.		
				Large.	Small.	Total.	Large.	Small.	Total.
		In.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
1	Single eyes	6	12	46.6	8.1	54.7	42.0	7.2	49.4
2	Single eyes	12	6	37.5	7.9	45.4	38.2	8.8	47.0
3	Two eyes	6	28	56.0	9.5	65.5	53.3	9.2	62.5
4	Two eyes	12	14	51.3	9.3	60.6	47.0	8.1	55.1
	Quarter medium tubers	12	18	60.6	12.3	72.9	60.2	9.5	69.7
	Quarter medium tubers	18	12	58.5	12.6	71.1	60.6	11.6	72.2
	Half medium tubers	12	36	66.2	18.9	85.1	64.4	17.5	81.9
	Half medium tubers	24	18	53.3	16.3	69.6	46.0	18.2	64.2

Seed pieces from large and small tubers.

No. of plat.	Mode of cutting.	Calculated yield per acre.					
		Early Rose.			Beauty of Hebron.		
		Large.	Small.	Total.	Large.	Small.	Total.
		Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
1	Small potatoes, two eyes	43.7	8.7	52.4	36.7	9.3	45.0
2	Large potatoes, two eyes, same weight	47.2	12.8	60.0	43.7	10.5	54.2
3	Large potatoes, two eyes, regularly cut	46.6	14.0	60.6	46.9	8.6	55.5
4	Large potatoes, all eyes cut out but two	70.0	15.1	85.1	65.3	16.9	82.2
5	Small whole potatoes, size of walnut	32.6	14.0	46.6	28.0	16.3	44.3

Notes and tabulated data are given for an experiment in which fertilizers were applied above and below seed potatoes of the Early Rose and Beauty of Hebron varieties cultivated by the trench and ridge systems.

The results of an experiment are tabulated and discussed in which cotton-seed meal, nitrate of soda, superphosphate, kainit, and muriate of potash, used singly and in different combinations, were compared with stable manure and with no manure on poor, sandy soil.

The following is a summary of the various experiments:

(1) The most promising new varieties of potatoes are Brownell No. 31, Early Delaware, Howe Premium, Late Puritan, Rural New Yorker No. 2, and Seneca Beauty. Southern seed gave larger yields than Eastern or Western seed. There was very little difference in the yields from Eastern and Western seed.

(2) The total yield increases in proportion to the size of the seed piece.

(3) Two eye cuttings from medium-sized tubers planted at a distance of 12 inches, or quarter pieces planted 18 inches apart, will generally insure the most profitable returns.

(4) There was no decided difference in results from applying the fertilizer above or below the seed.

(5) A mixture of superphosphate, potash, and nitrate of soda or cotton-seed meal gave the only profitable increase in yield. Two applications of nitrate of soda, one at the time of planting, the other about 5 or 6 weeks later, produced more favorable results than one application; but cotton-seed meal should be applied at the same time as the other fertilizers.

(6) As a fertilizer for potatoes a mixture of 400 pounds superphosphate, 250 pounds muriate of potash, 400 pounds nitrate of soda, and 800 pounds cotton-seed meal is suggested.

Sweet potatoes (pp. 174–182).—General statements are made regarding the culture of sweet potatoes, and field experiments are described in planting at different distances, with hill *vs.* flat culture, with small *vs.* large seed, and with fertilizers. A previous report on experiments with sweet potatoes may be found in Bulletin No. 11 of the station (see Experiment Station Record, vol. II, p. 555).

The yields for 2 varieties planted at distances of 1.5 by 3.5, 2 by 3.5, 2.5 by 3.5, and 3 by 3.5 feet are given in a table, those for the two intermediate distances being the largest.

In the case of 2 varieties flat culture gave considerably larger yields than hill culture, but for a third variety hill culture gave slightly the best results. Where large and small tubers were used for seed there were no great differences in the yields.

The tabulated results of an experiment in which muriate of potash or kainit was used in different combinations with superphosphates and cotton-seed meal, do not indicate in which form potash may be most profitably applied to sweet potatoes.

Notes and tabulated data are given for an experiment in which cotton-seed meal, nitrate of soda, superphosphate, kainit, and muriate of potash, used singly and in different combinations, were compared with stable manure and with no manure on a "stiff, red sandy clay soil with clay subsoil," on which Southern Queen and Pumpkin Yam potatoes were planted. The best results were obtained with complete fertilizers, but there were indications that the Southern Queen variety required relatively more nitrogen and less potash than the other. Nitrate of soda was much more effective than cotton-seed meal.

Tabulated data are given for a test of 9 varieties of sweet potatoes. The largest yields were produced by Pumpkin Yam, Southern Queen, Bermuda Sweet, and Georgia Yam.

Tomatoes (pp. 182–190).—Tests of varieties and an experiment with fertilizers are reported. Brief descriptive notes are given on 10 new

varieties of tomatoes, and general statements are made regarding a test of varieties, which was so interfered with by the prevalence of rot that detailed data are not given.

Notes and tabulated data are given for an experiment in which superphosphate, muriate of potash, cotton-seed meal, and nitrate of soda, used singly and in different combinations, were compared with no manure on hard clay soil with clay subsoil, on which Early Ruby and Ignotum tomatoes were planted. Only the complete fertilizers gave profitable returns. It was not clear whether nitrate of soda was more advantageous than cotton-seed meal. Relatively large rations of nitrogen, especially in the form of cotton-seed meal, seemed to prolong the time of bearing.

Forage plants (pp. 190–198).—An account of experiments with cowpeas, sorghum, and soja beans, in continuation of those reported in Bulletin No. 12 of the station (see Experiment Station Record, vol. III, p. 15).

Cowpeas planted on clay soil were fertilized with superphosphate, muriate of potash, kainit, and nitrate of soda, singly and in different combinations, 2 plats remaining unmanured. The best results were obtained with combinations of superphosphate and potash. Kainit proved more effectual than muriate of potash. The plants evidently gathered nitrogen from other sources besides the fertilizers. The yields of green and dry forage per acre are tabulated for 7 varieties of sorghum, white and yellow millo maize, Kaffir corn, teosinte, pearl millet, Blount Prolific corn, and Brazilian flour corn. As compared with corn, the other varieties of forage plants tested gave relatively larger results.

An experiment with soja beans indicated that they would compare favorably with cowpeas in the amount of forage produced per acre.

Kansas Station, Bulletin No. 25, December, 1891 (pp. 9).

EXPERIMENTS WITH SORGHUM, G. H. FAILYER, M. S., AND J. T. WILLARD, M. S. (pp. 117–125).—The work here reported includes tests of varieties, improvement by seed selection, and trials with fertilizers.

The season of 1891 was the most favorable for sorghum that we have had at this place for at least 8 years, the growing season being amply supplied with rain, followed by a rather dry fall, so favorable to maturation of a sorghum rich in cane sugar. A killing frost did not occur until October 7.

Only about 30 varieties were grown this year, the poorer ones having been rejected after 2 years' trial.

The highest percentages of cane sugar found in general samples of certain varieties is as follows: Undendebule 17.68, cross of Orange and Amber 17.07, Kansas Orange 16.82, Medium Orange 16.58, Link Hybrid 16.37, cross of Orange and Link Hybrid 15.81, Unkunjana 15.52, White Amber 15.40.

The selection of individual stalks of high sugar content and purity has been continued. Nearly 1,300 canes, from 10 varieties, were examined and 66 analyses made. The highest percentages found in a few of the varieties were, Undendebule 18.95, Kansas Orange 18.59, cross of Orange and Amber 18.25, Medium Orange 17.84, Link Hybrid 17.41, Unkunjana 16.94, cross of Orange and Link Hybrid 16.83, Early Amber 16.48.

The quality of the sorghum grown at this station in previous years has never approached the excellence shown by the percentages quoted above. This year's samples of standard sorts show 1 to 3 per cent more cane sugar than in previous years. Part of this improvement may be and probably is due to seed selection, but the propitious season is credited with most of the increase in sugar content.

Trial with fertilizers (pp. 123, 124).—This was on 15 fiftieth-acre plats, alternate plats remaining unmanured. The manured plats received a mixture of 200 pounds of nitrate of soda, 200 pounds of potassium sulphate, 300 pounds of superphosphate, and 100 pounds of plaster per acre; each of these materials in double the above amount used singly; 20 bushels of lime or 150 pounds of salt. The yield of canes and the tests of the juice are tabulated for the several plats. The results imply "that the fertilizers had little if any influence. The differences may easily be the expression of errors inevitably involved in plat experimentation. The greatest difference is shown in the plat receiving sodium nitrate, where there is an apparent increase of 0.88 per cent." The experiment is to be continued.

Kansas Station, Bulletin No. 26, December, 1891 (pp. 14).

TEST OF VARIETIES OF STRAWBERRIES, E. A. POPENOE, M. A., AND S. C. MASON, B. S. (pp. 127–138).—Desciptive notes and tabulated data for 71 varieties of strawberries planted in 1890. Most of these varieties were obtained from the Michigan Substation at South Haven. The results are illustrated with the aid of diagrams. The most productive varieties were Bomba, Bubach No. 5, Captain Jack, Crescent, Shuster Gem, and Warfield No. 2; those producing the largest berries were Bubach No. 5, Cumberland, Dew, Logan, Parry, and Sharpless; those showing the least susceptibility to leaf spot were Belmont, Bidwell, Bubach No. 5, Covell, and May King.

Kansas Station, Bulletin No. 27, December, 1891 (pp. 22).

CROSSED VARIETIES OF CORN, THIRD YEAR, W. A. KELLERMAN, PH. D., AND C. H. THOMPSON (pp. 139–158).—This is an account of experiments in 1891 in continuation of those of 1890, reported in Bulletin No. 17 of the station (see Experiment Station Record, vol. II, p. 722). In 1890, 62 crosses were harvested. Of these, 49 were planted in 1891, from which 43 crosses were harvested.

Eight of these showed no intermediate characteristics between the parents. Of this number 3 resembled the female parent, 2 the male parent, and 3 showed no resemblance to either parent. Of the remaining, 25 gave clear evidence of intermediate characteristics between the parents. This was shown in color in 5 cases, in the character of grains in 20 cases, and in both color and character of grains in 10 cases.

Of the crosses made in 1889 to improve varieties, 20 were harvested this year. Referring to the above, it will be seen that 8 of these gave no indications of a cross. Of the remaining 12, some showed exactly intermediate characteristics between the parents, and others resembled one parent more than the other.

Brief descriptions are given of each of the ears obtained as the result of the crossing. In one case a cross of the fourth year between Early White Dent and Golden Popcorn is described. From the uniformity of the ears produced it would appear that this cross is now fixed as a distinct variety.

Some blue kernels found on ears of corn whose immediate parents were known to have shown no kernels of this color, were planted and one of the resulting ears was artificially fertilized with pollen from the same stalk under conditions which kept it free from any possible intermediate cross. This ear contained 370 kernels.

Of these 206 were blue, 71 pink, 71 orange-yellow, and 22 pure white.

This result seems to be conclusive evidence that the blue of the grains planted was the product of atavism, and from the fact that all the planted grains were blue, the pink, yellow, and white grains in like manner must have reverted to other varieties. Five other ears from the same seed, but not inclosed—thus being exposed to the pollen of other varieties—showed the same variation in color, with a slightly smaller per cent of blue.

To show the prepotency of the blue corn, a large number of ears from other plats, growing within a radius of 25 yards, were examined. About half the number of unenclosed ears had from one to five blue kernels, while not one of the inclosed gave any traces of blue.

Louisiana Stations, Bulletin No. 13 (Second Series), (pp. 32).

SWEET POTATOES, H. A. MORGAN, B. S. A., AND B. B. ROSS, M. A. (pp. 314–342, figs. 16).—A brief history of the sweet potato is given, together with notes and tabulated data on 14 varieties grown at the Louisiana State Station. In an experiment in which cotton-seed meal, muriate of potash, and acid phosphate, singly and combined, were applied on sweet potatoes of the Georgia Yam variety on a soil of dark brown loam, the acid phosphate gave the largest yield. Cotton-seed meal seemed to make the potatoes irregular in shape. Where sweet potatoes were planted at distances of 8, 12, 15, and 18 inches apart in the row the results favored 15 and 18 inches. The following table gives the results of analyses of the varieties tested:

Analyses of varieties of sweet potatoes.

Variety.	Water.	Crude ash.	Crude protein.	Crude fat.	Crude fiber.	Nitrogen-free extract.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
New Jersey	66.54	1.07	1.57	0.60	0.89	29.30
Georgia Yam	65.03	1.01	2.49	1.32	0.79	29.34
Pumpkin Yam	67.83	1.07	1.95	0.75	0.98	27.40
Vineless	63.54	1.16	1.35	0.64	0.85	32.42
Delaware	69.45	1.22	2.08	1.28	0.70	25.24
Spanish Yam	60.85	1.02	1.75	1.06	1.02	34.29
Barbadoes	62.33	1.09	1.51	0.54	0.86	33.65
Southern Queen	63.29	1.04	1.62	0.57	0.86	32.59
Norton	61.42	1.08	1.71	0.71	1.09	33.97
Shanghai or California	65.18	1.04	1.69	0.97	0.95	30.15
Red Nansemond	63.46	1.30	1.47	0.73	0.98	32.04
Sugar	58.46	1.10	1.71	0.63	0.95	37.12
Peabody	66.06	1.09	1.41	0.62	0.73	30.07
Dog River	67.00	1.21	1.00	0.73	1.05	28.99

By covering the flowers with paper bags seed was obtained, which will be planted with a view to obtaining new varieties. Brief descriptions of the several varieties tested are given, and are accompanied in each case by an outline figure of a leaf. The following summary is taken from the bulletin:

(1) Those varieties which have the most ready sale in Louisiana immediately after digging are the Georgia Yam and Sugar.

(2) The most desirable mealy varieties (preferred in the Northern markets) are the Southern Queen, New Jersey, Barbadoes, and Spanish Yam, and probably Norton and Dog River.

(3) Varieties to be grown as food for stock are Red Nansemond, Pumpkin, and California.

(4) The Vineless requires further trial.

Massachusetts Hatch Station, Fourth Annual Report, 1891 (pp. 14).

This includes brief statements regarding the work of the station in chemistry, entomology, meteorology, agriculture, and horticulture, and the Treasurer's report for the fiscal year ending June 30, 1891. A colored plate illustrating the different stages of the Gypsy moth (*Ocneria dispar*) accompanies the text. The analyses made for the station during the year were as follows: Ash 2, fertilizers 24, fodder and ash 68, fodder 6, milk 2, moisture determinations 459, moisture and starch determinations 45, fungicides and insecticides 10.

The Japanese millets mentioned in the last Annual Report, together with two other species of millet and a number of varieties of soja bean, have been under further trial. The millets show remarkable cropping capacity. *Panicum italicum* in half-acre plats has yielded in one instance at the rate of 72 bushels of heavy seed and 2.16 tons of straw, and in another at the rate of 76 bushels of seed and 2.2 tons of straw per acre. This straw will be analyzed, but from its appearance it is judged that it must equal corn stover in feeding value. An experiment in feeding will be undertaken this winter. Another millet, *Panicum crus-galli*, yielded at the rate of 42.5 bushels of seed and nearly 7 tons of straw to the acre; and another, *Panicum miliaceum*, at the rate of 90.8 bushels of seed and 65 tons of straw. The latter when green was eaten with all the avidity which cattle usually show for green corn fodder, and promises to be a valuable crop for soiling or for the silo.

Several of the varieties of soja bean (*Glycine hispida*) which have been under cultivation prove well adapted to our soil and climate, and on soil of medium quality have yielded in different years from about 25 to 35 bushels to the acre. * * *

White mustard seed at the rate of about 16 bushels per acre has been raised, and was ripe in time for use in seeding for green manuring upon stubble land and in standing corn. Careful experiments in the use of this crop as a nitrogen conserver and soil improver have been begun.

Hemp of 2 varieties and flax of 3 have been successfully raised, but the experiment with flax, which occupied three fourths of an acre, has demonstrated the impossibility, at present prices, of growing the crop at a profit in this section.

The analyses of the morning and night's milk of the cows in the station herd during December, 1890, gave the following average results:

Breed.	No. of cows.	Solids.	Fat.
		Per cent.	*Per cent.*
Ayrshire	6	13.29	3.78
Holstein	5	12.10	3.26
Shorthorn	4	13.19	4.04
Jersey	3	13.91	4.96
Guernsey	1	16.35	6.79
Grade	21	13.23	4.18
Entire herd		13.17	4.11

Massachusetts Hatch Station, Meteorological Bulletin No. 38, February, 1892 (pp. 4).

A daily and monthly summary of observations for February at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

Michigan Station, Bulletin No. 80, January, 1892 (pp. 38).

FRUIT TESTING AT THE SOUTH HAVEN SUBSTATION, 1891, T. T. LYON.—This is the second year's report on tests of varieties of large and small fruits. The first report was issued as Bulletin No. 67 of the station (see Experiment Station Record, vol. II, p. 353).

Strawberries.—Tabulated data are given for 128 varieties, with descriptive notes on 21 of the more desirable varieties. Comparisons of planting in hills and matted rows showed the best results from the former method in most cases. The following varieties, named approximately in the order of maturing, are recommended for family use: Alpha, Haverland, Parker Earle, Belmont, Parry, Mount Vernon, and Gandy. For market purposes the following are recommended in the order of productiveness: Parker Earle, Beder Wood, Haverland, Enhance, Great Pacific, Bubach No. 5, and Mrs. Cleveland. "The last and lowest of these yielded 303 ounces of fruit from 24 plats, while Crescent under the same conditions yielded but 172 ounces."

Raspberries.—Tabulated data are given for 3 varieties of *Rubus idæus*, 5 of *R. neglectus*, 18 of *R. occidentalis*, and 15 of *R. strigosus*, with descriptive notes on 22 varieties. For home and market purposes the following red and yellow varieties are recommended: Hansell, Herstine, Reder, Cuthbert, and Golden Queen. Among cap varieties, Cromwell, Doolittle, Souhegan, Hilborn, and Nemaha are desirable for a family garden.

Blackberries.—Tabulated data are given for 21 varieties of blackberries and 2 of dewberries, with descriptive notes on 15 varieties. "Lucretia dewberry and Early Harvest blackberry (which ripen very nearly together), followed by Agawam or Kittatinny, and Taylor to close the season will be found a very satisfactory succession for a family

plantation of this fruit. For market, if covered in winter, the Wilson is found eminently profitable. If without winter protection, Snyder and Taylor will be found much surer, though smaller in size."

Currants.—Tabulated data on 14 red and white and 5 black varieties, and the Crandall currant. The last named is considered by the author of very doubtful value. The old varieties, White Dutch and Red Dutch, are thought to be as good as any.

Gooseberries.—Tabulated data are given for 11 varieties. Houghton, a small, smooth variety, seems to be hardy and productive.

Cherries.—Tabulated data for 19 Mazzard and 18 Duke and Morello, with brief descriptive notes on 12 varieties. "For a market list of sweet cherries a good selection would be Black Tartarian, Napoleon, and Downer; of Dukes and Morellos, Early Richmond, May Duke, Louis Phillippe, and Magnifique."

Mulberries.—Brief notes on the 5 varieties on trial at the substation.

Service berries.—Brief notes on 3 varieties.

Peaches.—One hundred and forty-nine varieties are now on trial. Detailed notes regarding them are deferred until the newer varieties have fruited.

Plums.—Eighty-one varieties are now on trial.

Grapes.—Tabulated data are given for 127 varieties. "Persons who prize quality and desire to secure it, even with slightly diminished productiveness and some additional care and labor, will find abundant satisfaction for dessert purposes from a plantation of the following, named as nearly as practicable in their order of ripening: Green Mountain or Winchell, Delaware, Lady, Brighton, Ulster, Iona, Jefferson, Agawam, and Diana. The following will afford a good succession for maket purposes: Moore Early, Worden, Niagara, Pocklington, Woodruff, and Eaton."

Pears.—Sixty-seven varieties have been planted.

Apples.—One hundred and forty varieties have been planted, but none have yet come into bearing. From previous experience of the author the following are recommended for family uses: Early Harvest, Sweet Bough, Jeffries, Munson Sweet, Shiawassee, Northern Spy, Early Strawberry, Garden Royal, Keswick, Dyer, Hubbardston, Lady Sweet, Primate, Jersey Sweet, Rhode Island Greening, Golden Russet, Chenango, St. Lawrence, Jonathan, Talman Sweet, and Roxbury Russet; for market purposes, Early Harvest, Lowell, Rhode Island Greening, Roxbury Russet, Red Astrachan, Shiawassee, Baldwin, Maiden Blush, Hubbardston, and Red Canada (top graft).

Quinces.—Brief notes on 9 varieties.

Nuts.—Brief notes on 5 varieties of chestnuts, 2 of walnuts, and 1 each of chinquapin and pecan.

Rhubarb and asparagus.—Brief additional notes on the varieties referred to in the previous report.

Mississippi Station, Bulletin No. 17, December, 1891 (pp. 16).

INSECTS INJURIOUS TO STORED GRAIN, H. E. WEED, M. S. (figs. 8).—Descriptive notes on the angoumois grain moth (*Gelechia cereallella*), black weevil (*Calandra oryzæ*), red grain beetle (*Silvanus cassiæ*), corn sap beetle (*Carpophilus pallipennis*), *Silvanus surinamensis*, *Tribolium ferrugineum*, and *Calandra granaria*. There are also suggestions for the repression of these insects, with special references to the use of bisulphide of carbon. The figures accompanying the text are original, with the exception of two, which are after Riley.

Mississippi Station, Bulletin No. 18, January, 1892 (pp. 4).

COTTON, TEST OF VARIETIES, E. R. LLOYD, M. S.—Tabulated notes on 46 varieties grown at the station in 1891. The varieties giving the most profitable yields of lint and seed were Eureka, Texas Storm-Proof, Allen, Bailey, and Drake Cluster.

Mississippi Station, Bulletin No. 19, January, 1892 (pp. 12).

SOUTHERN TOMATO BLIGHT, B. D. HALSTED, D. SC.—Owing to the prevalence of an undetermined disease of tomatoes in Mississippi, the author, who is connected with the New Jersey College Station, was employed by the Mississippi Station to make a special study of the disease. For this purpose he made observations in the field during 1891 and has since continued the work in his laboratory in New Jersey. This bulletin includes a preliminary account of these investigations, which are to be continued the coming season. The disease known as Southern tomato blight causes the wilting of the plant, which afterwards loses its green color and dies. The blight does not seem to be confined to any particular kind of soil, situation, or exposure. Microscopic examinations of the diseased portions of the plant revealed the presence of large numbers of bacteria, and further tests seem to show that these bacteria are the cause of the trouble. A bacterial disease of potatoes, melons, and other cucurbits has been studied, and inoculation experiments are reported which indicate that the bacteria found on these plants and on the tomato are of the same kind. The author makes the following practical suggestions with reference to the repression of this disease:

A soil may become so contaminated with bacteria from any one of the three crops as to make it unfit for either of the other two. Repetition of the same crop is of course not desirable.

The potato from the nature of its "seed" is best adapted to the dissemination of the blight, as it can be carried unobserved in the potatoes used in planting.

As the Bordeaux mixture has proved effective for the bacterial disease of the potato, spraying with this compound is recommended for all three crops when fear of blight is entertained.

Care should be taken to burn the diseased plants when found, and also all litter in the field at harvest time.

Nebraska Station, Bulletin No. 19 (pp. 12).

FARM NOTES FOR 1891, C. L. INGERSOLL, M. S. (pp. 203–214, plates 3).—Notes and tabulated data on 6 varieties of spring and 27 of winter wheat, 3 of rye, 4 of barley, 5 of corn, 13 of sweet corn, 2 of pop corn, 2 of broom corn, 3 of flax, 4 of sorghum, 3 of sweet potatoes, 7 of potatoes, 1 of peanuts, and 8 of onions; also on 5 species of osier willows and 13 of grasses and clovers; and on *Lathyrus sylvestris*, Chinese potato bulblets, Stachys tubers, Kaffir corn, and Jerusalem corn.

An experiment in topping corn is reported in which the yield seems to have been reduced by this treatment. The season was remarkable for its excessive rainfall and the prevalence of fungous diseases. The plates accompanying the bulletin contain illustrations of the heads of 27 varieties of winter wheat tested.

New Jersey Stations, Special Bulletin M, November 23, 1891 (pp. 19).

FIELD EXPERIMENTS WITH SOIL AND BLACK ROTS OF SWEET POTATOES, B. D. HALSTED, D. SC.—A report on experiments carried on in continuation of those recorded in the Annual Report of the station for 1890 (see Experiment Station Record, vol. III, p. 307). Reference is made to the descriptions of black rot (*Ceratocystis fimbriata*) and soil rot (*Acrocystis batatæ*) in Bulletin No. 76 of the station (see Experiment Station Record, vol. II, p. 416). In 1891 experiments with reference to the influence of different kinds of manures and fertilizers on the amount of soil rot and black rot, were conducted in a field that had been badly infested with soil rot. These experiments were in two series, one on 19 twentieth-acre plats and the other on 4 smaller plats. The results are stated in tables and notes and are illustrated with a diagram. In estimating the influence of the different fertilizers the tubers of the crop were classified as follows: (1) Large sound potatoes free from rot, (2) sound potatoes designated "seconds," (3) potatoes affected with black rot, (4) large marketable potatoes affected with soil rot, and (5) small marketable potatoes affected with soil rot. The result of each series of experiments may be summarized in the following table:

Weights of potatoes affected with black and soil rots.

FIRST EXPERIMENT.

Plat.	Manures and fertilizers.	Amount of fertilizers per acre.	Sound firsts.	Sound seconds.	Black rot.	Soil rot firsts.	Soil rot seconds.
			Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1	Hen manure	120 bushels	3.5	3.5	2.75	97	47
2	New York manure*	10 tons	11.5	7	38	122	47
3	Nothing		10	11	9	37	36
4	Cow manure	10 tons	14.5	6	16	193	35
5	Pig manure	15 tons	65	16	70	221	65
6a	Royal bone (2 rows)	500 pounds	50.5	16	17	37	33
6b	Royal bone (2 rows)	1,000 pounds	41	19.5	11.5	51	38
7	Nothing		25	32	5	70	58
8a	Potato phosphate (2 rows)	500 pounds	43	13	21.5	58	35
8b	Potato phosphate (2 rows)	1,000 pounds	41.5	13	19.5	59	16
9	Sulphate of potash, boneblack, nitrate of soda.	640 pounds	47	11	9	158	52
10	Nothing		6	2	2	50	34
11	Nitrate of soda, boneblack	480 pounds	22	10	2	70	47
12	Nitrate of soda, sulphate of potash.	320 pounds	38	13.5	6	116.5	44
13	Nothing		30	27	4	41	36
14	Sulphate of potash, boneblack.	480 pounds	47	59	9.5	105	58
15	Nitrate of soda	160 pounds	38	32	4.5	76	67
16	Nothing		24	33	1	36	42
17	Boneblack	320 pounds	19	18	1.5	56	75
18	Sulphate of potash	160 pounds	28	35	11	80	45
19	Nothing		17	31	0.5	19	21
	Total		621.5	408.5	261.25	1,741.5	933

SECOND EXPERIMENT.

Plat.	Manures and fertilizers.	Amount of fertilizers per acre.	Sound firsts.	Sound seconds.	Black rot.	Soil rot firsts.	Soil rot seconds.
1	New York manure		93	40	6.66	168	60
2	Horse manure		57	38.66	2.66	96	46.66
3	New York manure Phosphate Kainit	 280 pounds 400 pounds	140	28.66	11.33	140	37.33
4	New York manure Phosphate	 280 pounds	56	22	16.66	214.66	56
	Total		346	129.33	37	618.66	200

* This manure is made in the cities and is largely used by sweet potato growers.

As regards black rot it was found that while as a rule the most productive plat furnished the greatest amount, there were some exceptions. The various kinds of fertilizers in general materially increased the percentage of black rot, but this increase could not be definitely attributed to any one of the leading fertilizing elements. As regards soil rot, the indications were that the manures used favored the development of the rot much more than the commercial fertilizers did. The greatest effect was produced by cow manure, the next by hen manure, and the third by New York manure. "Growers have for some time considered kainit as a partial preventive of the soil rot, and while this single experiment is not sufficient to establish its efficiency, it certainly suggests that further tests of kainit should be made. Another apparent fact brought out by these tests is the need of organic matter in the soil for the profitable growth of sweet potatoes."

New Jersey Stations, Special Bulletin N, November 30, 1891 (pp. 16).

INSECTS INJURIOUS TO THE BLACKBERRY, J. B. SMITH (figs. 7).—Popular descriptions are given of the red-necked cane borer (*Agrilus ruficollis*), blackberry crown borer (*Bembecia marginata*), giant root borer (*Prionus laticollis*), and blackberry midge (*Lasioptera farinosa*), with suggestions regarding remedies. Special references are made to observations on these insects by the author in 1891 in southern New Jersey. Three of the figures accompanying the text are original, the others being after Riley.

The history of the gall maker has been more completely written and the dates of the various stages have been fully noted, while observations on the crown borer are for the first time carried on throughout an entire season, somewhat modifying the accepted accounts, for New Jersey at least. * * *

The life history of the crown borer differs from those previously published, in giving a 2-year period to the larva, the others giving positively or inferentially a period of 1 year only. * * * As a blackberry pest the *Prionus* larva has not, to my knowledge, been heretofore recorded. * * *

In some States raspberries suffer equally or more from these same insects, but in New Jersey the varieties grown are practically free from injury, so far as I have observed. Of the blackberries the Wilson, which for date, size, flavor, and price is the favorite with growers, is also the favorite with insects, and is the only one injured to any serious extent. I am inclined to believe that other varieties are also attacked, but are more resistant and show injury less.

New York State Station, Bulletin No. 38 (New Series), January, 1892 (pp. 10).

OYSTER SHELLS AS FOOD FOR LAYING HENS (pp. 3–10).—It is explained that the value of oyster shells as a source of material for egg shells has been questioned, it being claimed that its value for poultry lies solely in furnishing grit. To test this an experiment was made with six 1-year-old Leghorn hens, three of which were fed coarse ground oyster shells and three coarse broken glass instead. Both lots were kept confined in cleanly swept pens having a floor of matched boards. In the first period, March 30 to April 19, wheat, fresh cabbage, and a grain mixture composed of corn meal, wheat bran, wheat middlings, and old-process linseed meal, were fed to both lots; and in the second period, lasting until May 3, boiled eggs were added. The eggs were collected the last 10 or 12 days of each period. The percentages of water, ash, and calcium carbonate contained in each kind of food and in the eggs laid each period, and the amount of food consumed are tabulated for each lot. The results for the lot receiving oyster shells were as follows:

During the first period the hens laid 12 eggs, 1 pound of eggs being produced from 3.95 pounds of water-free food. These eggs contained calcium equal to 48.43 grams of carbonate of lime, the shells alone containing 47.74 grams. The grain and cabbage consumed and the drinking water given them contained altogether calcium equal to 7.62 grams carbonate of lime. The oyster shells taken by them contained 93.80 grams carbonate of lime.

During the second period the hens laid 21 eggs, which were produced at the rate of 1 pound for every 2.59 pounds of water-free food. These eggs contained calcium

equal to 87.88 grams carbonate of lime, the shells alone containing 86.6 grams. The food consumed and drinking water given them contained calcium equal to 10.08 grams carbonate of lime. The oyster shells taken by them contained 180.99 grams carbonate of lime. Of the carbonate of lime contained in the eggs during the first period, 40.81 grams (over 84 per cent), and of that in the eggs during the second period, 77.80 grams (over 86 per cent), are unaccounted for, except by the carbonate of lime in the oyster shells, of which 99.2 grams were consumed during the first period and 191.4 grams during the second.

The difference is so great that no other conclusion seems possible than that the egg shells were constructed from material supplied in large part by the oyster shells.

These hens lost in weight a total of 5 ounces during the first period and a total of 2 ounces during the second, a change in weight of little consequence and one that might have occurred at any time within a few hours.

The lot receiving pounded glass did not lay as well as the other lot, and two of the hens became sick, but recovered after a few days. The sickness is believed to be due to excessive amount of glass swallowed, which amounted to 31.3 per cent of the total water-free food when given *ad libitum*, and to 26.1 per cent when the consumption was limited.

These hens gained in weight during the first period 11 ounces and lost during the second period 9 ounces. Although fewer eggs were laid by this lot the shells were lighter, being in the first period 8.12 per cent of the total weight of the eggs and in the second period 6.18 per cent, while the shells of eggs laid by the lot having oyster shells formed 9.67 per cent and 9.5 per cent of the total weight of the eggs.

The egg shells contained 92.42 per cent of carbonate of lime, and the ash of the eggs, exclusive of shell, 4.96 per cent of calcium, equal to 12.4 per cent of carbonate. The eggs for the first period contained 1.01 per cent, and those of the second 0.98 per cent of ash. * * *

The amount of lime calculated as carbonate found in the eggs exceeded that in the food and drinking water by 3.9 grams for one period and nearly 3 grams for the other. While the glass taken during one period contained lime, the equivalent of 116.63 grams of carbonate, and during the other of 38.56 grams, it does not appear probable that any of this was available as egg-shell material, for it existed in combination with various insoluble silicates. Treatment of the finely-powdered glass with the ordinary acids failed to dissolve a trace of lime, and fusion with alkaline carbonates was necessary to its estimation. Upon examination of the excrement, of which during the first period over 72 per cent of the air-dried substance consisted of fragments of glass large enough to be easily removed by washing, a very few small rounded fragments of limestone were found which must have been swallowed by the hens previous to their close confinement and retained for from 10 to 20 days. These small pebbles of limestone had been subjected to conditions which are seen to have made oyster shells available material, and it is probable that enough lime was dissolved from them or from smaller fragments, no appreciable portions of which were left in the excrement, to have supplied the 3 or 4 grams of lime. * * *

[In conclusion,] the feeding of oyster shells during the laying season, where they can be cheaply obtained, is recommended. One pound will contain lime enough for the shells of about 7 dozen of eggs.

Fine gravel containing limestone will probably as well supply the deficiency of lime existing in most foods, but the use of some sharper grit with it may be of advantage.

Long or sharp splinters of glass or dry bone should be avoided. For hens, the size of particles of grit had better be larger than that of a kernel of wheat and should be smaller than that of a kernel of corn.

An unlimited supply of pounded glass has been attended with no bad result when the food and other grit available to the fowls contained an abundance of lime, but when the food was deficient in lime and no other grit was attainable, hens ate an injuriously large amount of glass.

New York State Station, Bulletin No. 39 (New Series), January, 1892 (pp. 23).

SKIM MILK FOR GROWING CHICKENS (pp. 11–15).—Two broods of chickens, one containing 14 and the other 16, were kept in separate pens and fed on wheat, a mixture of corn meal, bran, middlings, and linseed meal, and skim milk. One pen received meat scraps also, and all received a little green clover towards the close of the trial. The chickens were from 1 to 3 days old at the beginning of the trial. A hen was kept with each pen until the chickens were well feathered ($5\frac{1}{2}$ to $7\frac{1}{2}$ weeks). The skim milk was usually fed sweet. The chickens and hens were weighed weekly. The results are tabulated, showing gains, food consumed, cost, etc. In the estimates of cost the grain mixture was valued at \$20 per ton, the wheat at \$1 per bushel, the skim milk at 25 cents per hundred pounds, the clover at \$2 per ton, and the meat scraps at 2.5 cents per pound.

With one pen the average cost of food for every pound increase in weight during the whole time was 5.66 cents; for the other the cost of increase for all but the last 2 weeks was 5.36 cents, and during these 2 weeks 5.63 cents. In one pen the chickens averaging 2.4 pounds weight at $10\frac{1}{2}$ weeks of age were grown at a cost for food of 5.31 cents per pound, or an average of 12.7 cents apiece; in the other pen the chickens averaging 2.4 pounds at $11\frac{3}{4}$ weeks of age cost for food 5.36 cents per pound or 12.9 cents apiece. This cost of production of course includes the cost of feeding the hen during the first few weeks. * * *

Under ordinary conditions chickens ought to be hatched, making a fair allowance for value of eggs and food for sitting hens, at a cost of less than 5 cents apiece. The highest cost per pound gain during any week while growing chickens to 3.5 pounds average weight, was less than 7 cents, and the cost averaged much less than 6 cents. At the prices generally obtained for chickens of this and lesser weights the growth was certainly a profitable one. With chickens having the liberty of the fields it seems reasonable to expect a still cheaper production of meat, and it would appear that a profitable use for some of the skim milk of the farm would be in the growing of chickens for home use or for the market.

FEEDING TALLOW TO HENS (pp. 16–21).—In order to observe the effect of feeding more than an average amount of fat in a ration, two pens of hens (eight in each pen at the beginning) were fed from March 3 to October 6, one having as much tallow as was readily eaten, with a moderate grain ration, and the other having a similar grain ration with old-process linseed meal substituted for the tallow. The fowls were all Brown Leghorns, except two Game Wyandottes in each pen. The nutritive ratio of the tallow ration was 1:6.75 and of the linseed-meal ration 1:4.47. The ratio of fat to the total water-free food was 1:8.1 in the tallow ration and 1:29.5 in the other. The results are fully tabulated by periods of from 21 to 48 days.

The average egg product was somewhat in favor of the hens having less fat in their food and the average size of the eggs laid by them was a little larger. However, during one period of 42 days in July and August, more eggs were obtained from the hens having tallow. During the first period, while the hens were newly confined, there were few eggs laid, and during the latter period many hens were molting.

The greatest difference observed was that the hens having tho linseed meal nearly all molted at the same time, earlier in the season, and more rapidly. Only a few of the hens which had been fed tallow had begun to molt at the close of this feeding trial, October 6, by which time several hens from the other pen were in new plumage. The tallow ration was apparently too deficient in nitrogen to encourage the growth of new feathers, and the results are in support of the advice to feed during the summer a highly nitrogenous ration to help early molting.

The amount of tallow fed was not enough to affect the health of the fowls, and they were throughout in better apparent condition than those of the other pen. The average weight of the tallow-fed hens was but slightly the greater.

FEEDING SALT TO HENS (pp. 22, 23).—A trial was made with twelve 2-year-old hens (Brahmas, Cochins, and Game crosses) to get indications of the amount of salt which may be fed without injury. The hens were divided into two lots, which were kept in separate pens, and both received the same food (mixed grain, wheat, and grass), except that salt was mixed in the food of one lot at the rate of from 0.021 ounce to 0.063 ounce per fowl daily, and the other lot received no salt. This feeding lasted 2 months. After that both lots were allowed salt.

Until the amount of 0.063 ounce per day for each hen was fed (at the rate of 6.3 ounces, nearly one half pint a day for one hundred hens) no bad effects were observed. This amount, however, was sufficient to cause diarrhea in two of the hens. Upon reducing the amount of salt to 0.042 ounce per hen the trouble disappeared without other treatment. * * *

The total gain in weight per fowl during the first 2 months was, for those having salt 8.2 ounces, and for the others 10.5 ounces. During the last month it was for those having had salt on an average of 2.8 ounces and for the others 8.7 ounces. The total grain food consumed per day was for the salt-fed pen 4.17 ounces per fowl during first 2 months and 4.28 ounces during the last month. For the other pen the average was 3.4 ounces per day for the first 2 months and 4.13 ounces for the last month. During the first 2 months 94 eggs were obtained from the pen having salt, and during the last month but 1 egg, while 47 eggs were obtained from the other pen during the first 2 months and 14 during the last month. The number of eggs laid during this trial is not of great significance, as it was about the end of the laying season and the hens were old. * * For mature fowls it is probable that salt at the rate of 1 ounce per day for one hundred fowls could, under ordinary conditions, be fed without injury.

North Carolina Station, Thirteenth and Fourteenth Annual Reports, 1890 and 1891 (pp. 22 and 31).

These include an outline of the work in the several divisions of the station, statements regarding the equipment of the station, a list of the bulletins issued in 1890 and 1891, and financial reports for the fiscal years ending June 30, 1890 and 1891. The station made an exhibit of its work in different lines at the Southern Exposition at Raleigh, North Carolina, in the fall of 1891. In order to bring the station into closer

relations with the farmers of the State, various farmers' organizations have been invited to elect committees who shall keep in direct communication with the station and receive and distribute such information as the station may give through its publications and by correspondence.

Test of a new method for curing tobacco.—A brief account is given of experiments in which the common method for curing tobacco was compared with a new process, known as the "Snow wire cure," by which the separate leaves are cut from the stalk as they ripen in the field and are cured separately. The test indicated that the new process saves a larger quantity of leaves, and that these are of better quality.

Cultivation of tea.—Some interest has lately been revived in the culture of the tea plant in North Carolina. Tea of good quality has been raised on a small scale in the State. The station has undertaken to have this matter tested in different localities in the State.

Tests of new fruits.—The station is distributing young fig trees in sections of the State where they seem likely to thrive.

Experiments with a variety of Japanese oranges called Oonshin are in progress, and it is hoped that this will prove a sufficiently hardy variety to be grown in the eastern and southern sections of the State.

Fertilizer inspection.—In accordance with a recent law passed by the legislature of the State, the tonnage system of taxing fertilizers has been substituted for the privilege tax on different brands. Under the new system the number of brands sold in the State has increased from 84 in 1890 to 295 in 1891. The station does not favor the tonnage system, believing that it very greatly increases the difficulty of exercising a proper control of the fertilizer trade. The following digest of the fertilizer laws now in operation in the State is taken from the Report for 1890:

No manipulated guanos, superphosphates, commercial fertilizers, or other fertilizing material shall be sold or offered for sale unless a tonnage charge of 25 cents per ton has been paid. Each barrel, package, or bag shall have attached a tag representing this fact, which tags shall be issued by the Commissioner of Agriculture, according to regulations prescribed by the State department of agriculture. The department of agriculture has power at all times to have samples collected of any fertilizer or fertilizing material on sale, which must be taken from at least 10 per cent of the lot selected. These samples are taken from the goods in the hands of dealers after they are shipped from the manufactories, and accordingly represent the true grade of fertilizers offered for sale.

Every package of fertilizer offered for sale must have thereon a plainly printed label, a copy of which must be filed with the Commissioner of Agriculture, together with a true sample of the fertilizer which it is proposed to sell, at or before the shipment of such fertilizer into the State, and which label must be uniformly used and not changed during the year. This label must set forth the name, location, and trademark of the manufacturer, also the chemical composition of contents, and real percentage of the ordinary ingredients, together with date of analysis, and that all charges have been paid. There must be no variation in the guarantied percentages, but the bags must be branded with the exact chemical composition of the contents.

It is a misdemeanor, and a fine of $10 for each bag, for an agent or dealer to offer for sale any such fertilizer or fertilizing materials not properly tagged, or a consumer to remove it, or a railroad agent to deliver it. Fertilizers which now have a license

to sell (secured last year) will not be required to pay the charge or to be tagged until expiration of their licenses. All others on sale must be tagged properly at once. Goods kept over from last season must be tagged to represent this fact, and all dealers are required to report the amount on hand at the close of the fiscal year on November 30. No fertilizers can be sold with a content less than 8 per cent of available phosphoric acid, 2 per cent of ammonia, and 1 per cent of potash. Kainit, cotton-seed meal for fertilizing purposes, and other fertilizing materials must now be inspected and analyzed, and possible adulteration so prevented.

Any fertilizer that is spurious and does not contain ingredients as represented by the label is liable to seizure, and after being established on trial its value is recovered by the board of agriculture. Any person who offers for sale fertilizers or fertilizing material without having attached thereto labels as provided by law is liable to a fine of $10 for each separate package, one half, less the cost, going to the party suing and the remainder to the department; and if such fertilizer is condemned the department makes analysis of the same and has printed labels giving the true chemical ingredients of the same put on each package, and fixes the commercial value at which it may be sold. The department of agriculture can require agents of railroads and steamboat companies to furnish monthly statements of the quantity of fertilizers transported by them. The experiment station analyzes samples of fertilizers taken by the official inspectors and publishes the same whenever needful.

North Carolina Station, Bulletin No. 80*a*, October 1, 1891 (pp. 26).

SYNOPSIS OF PUBLISHED WORK OF THE BOTANICAL AND ENTOMOLOGICAL DIVISIONS OF THE STATION, G. MCCARTHY, B. S.—This includes popular summaries of station bulletins on the following subjects: The quality of commercial seeds, Bulletins Nos. 59, 63, and 67 (see Experiment Station Record, vol. I, pp. 137 and 286); weed pests, Bulletin No. 70 (see Experiment Station Record, vol. II, p. 164); fungous diseases of plants, Bulletin No. 76 (see Experiment Station Record, vol. III, p. 172); forage plants, Bulletins Nos. 60 and 73 (see Experiment Station Record, vol. II, p. 600); and noxious insects, Bulletin No. 78 (see Experiment Station Record, vol. III, p. 175).

North Carolina Station, Bulletin No. 81, December 15, 1891 (pp. 26).

COTTON-SEED HULLS AND MEAL FOR STEERS, J. R. CHAMBERLAIN (pp. 3–10).—This experiment was made with four steers ranging in weight from 738 to 1,026 pounds, to study the value of cotton-seed hulls, when supplemented with cotton-seed meal, for fattening steers. The feeding trial lasted from October 21, 1889, to January 13, 1890—84 days. During this time the hulls were fed *ad libitum* (usually 15 to 20 pounds per head), with from 3 to 5 pounds of cotton-seed meal per head daily. The food consumed and gains of each steer are tabulated, together with statements of the financial results, based on hulls at $3.50 and cotton-seed meal at $24 per ton. At the end of the feeding "the animals were well fattened, healthy, and still growing, but notwithstanding this, there appeared indications which seemed to show that the digestion of the animals had been impaired." The gains made ranged from 132 to 182 pounds, and averaged 148 pounds. The average cost of the food during

the trial was $7.25 per head. The steers were sold at 4 cents per pound live weight. The net returns from the feeding, not taking the value of the manure into account, ranged with the individual animals from $6.89 to $10.57.

FEEDING COTTON-SEED HULLS AND MEAL FOR PRODUCTION OF BEEF, F. E. EMERY, B. S. (pp. 11–21).—*First experiment* (pp. 11–18).—This was with four animals, two native steers about 3 years old and two grade Shorthorn heifers. One heifer and one steer received cotton-seed meal and hulls exclusively; the other two animals received cotton-seed meal and hulls, with the addition of sweet potatoes or corn silage in the case of the heifer and of corn stover or silage in the case of the steer. The trial lasted from November 12, 1890, to January 31, 1891. The animals were bought at the beginning of the trial at 3 cents and sold at the close at 3.5 cents per pound live weight. The tabulated results show very little difference in the gains made by the animals. The best financial results were obtained with the steer receiving corn stover or silage in addition to the meal and hulls, and the next best by the steer and heifer receiving cotton-seed meal and hulls exclusively.

Second experiment (pp. 18–21).—Four oxen were fed for four periods of 20 days each, to compare cotton-seed hulls and corn silage when fed with cotton-seed meal. In the first period all received silage; in the second and third, two received silage and two others cotton-seed hulls; and in the fourth period all received silage. The food consumed, gains made, and the financial results are tabulated. The latter are based on cotton-seed meal at $21, hulls at $2.50, and silage at $5 per ton, and beef at 3.5 cents per pound. "In this experiment silage at $1 per ton would about equal cotton-seed hulls at $2.50 per ton, without cost of transportation."

Third experiment (pp. 21, 22).—One cow fed for 57 days (April to June) on cotton-seed hulls and meal, with small additions of silage, clover, or prickley comfrey, gained 111 pounds live weight at a cost for food of $5.31. She was purchased at 2.5 cents per pound and sold at 3.5 cents, giving a net profit of $6.37, exclusive of manure.

An 880-pound bull stag fed from July 4 to September 1 exclusively on cotton-seed hulls and meal gained 141 pounds live weight at a cost for food of $5.24. "This left a fair profit for the feeding under cover during warm weather."

Summary of results thus far obtained in these feeding experiments.

(1) All the animals in these experiments remained in a healthy condition and at no time did their digestion seem impaired except with two steers in the first trial.

(2) Cotton-seed hulls and meal are unquestionably very cheap and valuable articles of cattle food for fattening purposes.

(3) The most suitable time to fatten stock on cotton-seed hulls and meal is during the fall and winter months, when these articles can be obtained fresh from the oil mill.

(4) If a supply of hulls and meal is kept over, stock thin in flesh may be profitably stall-fed on them for the block during the hot weather, if managed with proper care.

(5) All animals that are stall-fed during warm weather should have well-aired quarters which can be cheaply darkened to check attacks of flies.

(6) The profit from fattening stock depends largely on the facilities for buying and selling to advantage.

(7) Care in stable management and regularity in feeding and watering stock, as well as quietness and attention to the comfort of each individual, add much to the profits.

(8) The manure is worth enough to pay for feeding and caring for the animals.

(9) In late feeding of cotton-seed hulls and meal care should be exercised in selecting these articles.

(10) If hulls become rancid the smell will indicate it.

(11) Cotton-seed meal is colored dark by age and is then dangerous food.

(12) In our earliest experiments cotton-seed hulls and meal were fed in different proportions. After careful observation it was decided that the steers did best when 1 pound of cotton-seed meal was fed for every 4 pounds of cotton-seed hulls. In this ration the ratio of protein to carbohydrates is very narrow. In all rations as much was fed as the steers would eat up clean.

PRACTICAL TESTS OF THE DIGESTIBILITY OF COTTON-SEED HULLS AND MEAL, F. E. EMERY, B. S., AND B. W. KILGORE, B. S. (pp. 23-26).—A briefer account of an experiment reported in Bulletin No. 80*c* of the station (see Experiment Station Record, vol. III, p. 452).

North Carolina Station, Bulletins Nos. 80*e* and 81*a* (Meteorological Bulletins Nos. 25, 26, and 27), November 15 and December 31, 1891 (pp. 16 and 31).

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, OCTOBER, NOVEMBER, AND DECEMBER, 1891, H. B. BATTLE, PH. D., AND C. F. VON HERRMANN.—Notes on the weather, monthly summaries, and tabulated daily records of meteorological observations by the North Carolina weather service coöperating with the United States Weather Bureau. The bulletins are illustrated with maps of North Carolina showing the isothermal lines and the total precipitation at the stations in different parts of the State.

North Carolina Station, Bulletin No. 82, January 15, 1892 (pp. 19).

FERTILIZER ANALYSES AND THE FERTILIZER CONTROL, H. B. BATTLE, PH. D.—This includes analyses of 227 samples of commercial fertilizers collected within the State during 1891; a digest of the State fertilizer laws; and freight rates from the seaboard to points in the interior of the State, corrected to January 1, 1892.

Pennsylvania Station, Annual Report, 1890* (pp. 270).

FINANCIAL STATEMENT (pp. 13, 14).—This is for the fiscal year ending June 30, 1890.

REPORT OF DIRECTOR (pp. 15-18).—This includes a list of the bulletins issued during the year, a brief statement regarding the analyses

* The Report of the station is published as part II of the Annual Report of the Pennsylvania State College for 1890.

of commercial fertilizers made by the station chemist for the State board of agriculture, descriptions of the new dairy house of the station and the additional facilities for feeding experiments, and general statements regarding the equipment and work of the station. The report is illustrated with plans of the dairy house and the additions to the farm buildings.

During the year experiments were made on 327 plats and with 14 animals; 1,373 samples of crops, fodders, dung, and milk were taken; the number of weighings is estimated at between 8,000 and 9,000. In the chemical laboratory there were made 5,992 determinations of fertilizers, and 6,973 of fodders, dung, milk, soils, etc., in all 12,965.

FEEDING STANDARDS AND COMPOSITION OF FEEDING STUFFS, H. P. ARMSBY, PH. D. (pp. 19–26).—A popular discussion of the ingredients of the animal body and of feeding stuffs, the fuel value of foods, Wolff's standards, and the calculation of rations.

ON THE RELATIONS OF LIVE STOCK TO FERTILITY, H. P. ARMSBY, PH. D. (pp. 27–30).—A popular discussion on this subject, with a tabulation of the percentages of fertilizing ingredients contained in a large number of farm products and feeding stuffs.

INDIAN CORN AS A GRAIN AND FORAGE CROP, W. H. CALDWELL, B. S. (pp. 30–43).—This consists of a discussion of the results of tests of varieties of corn, being a continuation of the work on this subject reported in Bulletins Nos. 7 and 11, and in the Annual Reports of the station for 1888 and 1889 (see Experiment Station Record, vol. I, p. 143; vol. II, p. 127; vol. III, p. 453; and Experiment Station Bulletin No. 2, part II, p. 121). The data tabulated include the yields of 11 flint and 15 dent varieties, the relation of parts of the plant and statements of the gain in dry matter by allowing the crop to mature, and of loss of dry matter in field curing. The latter determinations "are not wholly satisfactory, and further data are desired before conclusions are drawn."

SILAGE AND THE CORN CROP, H. P. ARMSBY, PH. D., W. FREAR, PH. D., AND W. H. CALDWELL, B. S. (pp. 43–123, plates 2).—Under this heading are reported the results of determinations of the coefficients of digestibility of corn and of silage, by W. Frear; losses in the silo, by H. P. Armsby; the relative feeding value of silage and fodder corn, by H. P. Armsby; and the yield of food per acre, by H. P. Armsby.

Digestibility of the corn crop and of the silage and fodder made from it (pp. 45–69).—Determinations were made of the coefficients of digestibility of fodder corn as put into the silo and of corn silage from the same with two grade Southdown sheep, and of field-cured fodder corn and silage with two grade Devon steers. The corn used in all cases was immature Burrill and Whitman Ensilage corn. The animals were in each case fed exclusively on the fodder to be tested for about 2 weeks, the excreta being collected during the last 5 to 7 days. The composition of the corn fodder and silage are given in each case. The coefficients of digestibility found are as follows:

Coefficients of digestibility found for corn fodder and silage.

	Dry matter.	Crude ash.	Crude protein.	True albuminoids.	Crude cellulose.	Nitrogen-free extract.	Crude fat.
Corn fodder as put into the silo:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sheep No. 1	50.88	21.43	20.13	....	45.47	57.09	73.98
Sheep No. 2	53.66	34.16	28.14	....	46.64	61.42	82.25
Poor field-cured corn fodder:							
Steer No. 1	63.92	25.57	35.95	33.72	74.26	65.55	84.23
Steer No. 2	57.60	9.90	22.39	22.23	66.73	59.92	65.66
Silage from coarsely cut corn, loosely packed:							
Steer No. 1	65.92	46.35	48.50	40.55	77.81	70.27	85.18
Steer No. 2	66.19	39.73	44.96	36.45	72.61	46.05	83.73
Silage from finely cut and crushed corn, closely packed:							
Steer No. 1	68.10	35.95	43.99	31.98	77.56	69.74	76.58
Steer No. 2	60.36	18.62	32.39	19.74	71.64	59.82	74.71
Sheep No. 1	56.02	7.30	21.97	3.70	67.69	57.27	69.01
Sheep No. 2	51.53	19.38	21.02	2.70	59.53	52.61	67.53

"Altogether the fine-cut, crushed silage differs in composition from the original fodder in having less sugar and starch and more protein, fiber, and ash, though it has an equal amount of dry matter. There is little difference in their digestibility."

The results are cited of previous determinations at the station of the composition and coefficients of digestibility of corn at different stages of growth.

The results are also given of the determination of the coefficients of digestibility of poorly cured clover and timothy hay by two grade Devon steers, which were fed from April 9 to 17 exclusively on this material. The hay used "was grown on the station farm in 1889, and contained a large proportion of clover. The season was wet and the growth of the grass was very rank so that it lodged. The hay was cut late and was wet while curing." The composition of the hay is given. The coefficients of digestibility found were as follows:

Coefficients of digestibility found for a mixture of clover and timothy hay.

	Dry matter.	Crude ash.	Crude protein.	True albuminoids.	Crude cellulose.	Nitrogen-free extract.	Crude fat.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Steer No. 1	55.30	44.82	37.45	31.44	51.44	59.43	58.10
Steer No. 2	54.29	39.91	37.91	31.96	52.12	59.52	58.09

Losses in the silo (pp. 69–79).—The experiments here reported are in continuation of those of the previous year reported in the Annual Report of the station for 1889, pp. 113–137 (see Experiment Station Record, vol. III, p. 457). The variety of corn used was Burrill and Whitman Ensilage, which had been raised from seed planted in drills at the rate of about one half bushel per acre. It was cut "while still comparatively immature." The silo used was a small wooden one

divided into four pits, each measuring about 6 by 10 feet. These separate pits were filled as follows:

No. 1, filled September 23. The fodder was cut about three fourths of an inch long and shredded. It was carefully packed in the silo, leveled off, covered at once with building paper and boards, then with another layer of building paper and a second layer of boards, and finally weighted with about 3,800 pounds of stone; about 9.75 tons of material was put into this pit. * * *

No. 2, filled September 20. In this pit the material was cut about 1 inch long, the sides and corners were tramped, and the fodder heaped up in the middle and left to itself. As soon as it had settled to a level with the top of the pit it was covered with building paper and straw; 7.83 tons of material was put into this pit.

No. 3, filled September 23. This pit was filled in the same manner as No. 2, except that the material was cut about 2 inches long instead of 1; 7.63 tons of fodder was put into the pit. * * *

No. 4 was filled with stover from our ordinary crop of field corn, the ears being first broken off and laid in the shallow windrows to cure. So much of this material as was preserved in the center of the pit yielded a silage of apparently excellent quality, but the stover was comparatively dry when put in and did not pack well, so that there was a very large loss by molding at the top and sides and no attempt was made to determine the amount of material lost.

Samples were taken of the fodder at the time it was placed in the pits, and of the silage produced. The analyses of these are given as follows:

Composition of corn fodder and silage from the same.

	Water in fresh material.	In 100 parts of dry matter.					
		Crude ash.	Albuminoids.	Non-albuminoids.	Crude cellulose.	Nitrogen-free extract.	Crude fat.
Pit No. 1, corn fodder finely cut, shredded, and closely packed in silos:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Corn fodder	79.35	6.05	4.65	0.82	29.05	54.40	5.03
Corn silage	80.91	6.60	4.82	1.20	35.46	46.99	4.93
Pit No. 2, corn fodder finely cut and loosely packed in silo:							
Corn fodder	79.18	5.14	3.80	1.25	29.35	55.42	5.04
Corn silage	82.07	6.14	5.18	1.17	35.86	47.80	3.85
Pit No. 3, same as No. 2 except cut coarser:							
Corn fodder	78.10	5.20	4.02	1.14	29.50	55.39	4.75
Corn silage	79.90	6.17	5.12	0.85	32.89	49.90	5.07

From the composition a calculation is made of the total amount of nutrients put into and recovered from each pit. In the case of pit No. 3 a portion of the spoiled silage was taken out and sampled, but was not weighed, consequently the apparent loss as given in the subsequent table is probably too large for this pit. "The figures have been included because they show that the losses can not have been greater than the amount stated." The calculated loss in the silo by fermentation, that is the difference between the amount of nutrients put in and the amount recovered in the good and spoiled silage, is given as follows:

Losses by fermentation.

[The sign + signifies an apparent gain.]

	Pit No. 1, shredded.		Pit No. 2, medium.		Pit No. 3, coarse.*	
	Pounds.	Per cent of each ingredient.	Pounds.	Per cent of each ingredient.	Pounds.	Per cent of each ingredient.
Fresh substance	2,887	....	3,885	....	2,270	....
Ash	0	0	+ 1†	0.60†	+ 1	+0.58
Albuminoids	21	11.23	+13	+10.48	+ 4	+2.99
Non-albuminoids	+ 4	+12.12	14	34.15	17	44.74
Crude fiber	91	7.78	308	32.18	137	13.96
Nitrogen-free extract	745	34.02	811	44.88	581	31.39
Fat	70	34.48	108	65.86	41	25.79
Total dry matter	923	22.92	1,227	37.63	771	23.07
Total protein	17	7.73	1	0.61	13	7.53
Digestible:						
Albuminoids	11	17.19	+15	+46.88	+15	+39.49
Non-albuminoids	+ 4	+12.12	14	34.15	17	44.74
Crude fiber	71	7.82	248	33.58	127	16.60
Nitrogen-free extract	518	33.95	629	49.96	424	32.87
Fat	54	34.63	81	64.29	22	18.03
Total digestible organic matter	650	24.19	957	43.48	575	25.52
Total digestible protein	7	7.22	+ 1	+1.37	2	2.63

* The amounts in these columns are too small.

† Corrected. The per cent of ash found in this sample was abnormally high.

The above losses by fermentation in the silo and the results obtained in ten experiments at the Wisconsin Station and one at the Missouri Station are compared with the losses by field curing found in seven experiments at the Wisconsin Station, four at the Vermont Station, and one at the Pennsylvania Station. The essential results are briefly summarized as follows:

Percentage loss of dry matter.

	Ensiling.	Field curing.
	Per cent.	*Per cent.*
Greatest loss	37.63	36.61
Average loss	20.36	19.87
Least loss	8.30	11.57

These results seem to justify the following conclusions:

(1) The loss in ensiling is likely to be, on the average, practically the same as that suffered in field curing under favorable conditions. We have no sufficient data for estimating what the loss in field curing would be in an unfavorable season.

(2) It appears that on the average we must count on losing about one fifth of the dry matter of the corn crop in the silo and about the same amount if it is field cured in a favorable season.

(3) The losses both in ensiling and field curing vary greatly, according to the conditions under which the process is carried out.

Relative feeding value of silage and fodder (pp. 79–118).—Three experiments are reported, the first to compare corn silage and corn fodder for

fattening steers, the second to compare corn silage and corn fodder for milch cows, and the third to compare corn silage and roots for milch cows.

In the first experiment six grade Shorthorn steers were fed like rations during a preliminary period of 38 days, and then divided as nearly as possible into two equal lots. Both lots received the same grain ration at all times, namely, 5 pounds of corn-and-cob meal, 5 pounds of bran, and 2 pounds of cotton-seed meal per animal daily. During the first period, January 24 to March 17—52 days—lot 1 received silage and lot 2 field-cured fodder corn. During the second period, March 17 to April 11—25 days—the feeding was reversed, lot 1 receiving field-cured fodder corn and lot 2 silage. The amount of fodder corn given was regulated by the appetites of the animals, and the amount of silage given was such as to furnish an amount of dry matter equal to that in the ration of fodder corn. The analyses of the feeding stuffs used and the uneaten residues are given, together with the amounts of food consumed and the fluctuations in live weight. The latter are illustrated by a diagram. The conclusions of the author are that "(1) the fodder and silage were eaten equally clean; (2) the use of silage did not materially increase the total amount of water consumed in food and drink together; and (3) the amount of food eaten per pound of gain was substantially the same for both rations."

In the second experiment, in which corn silage was compared with corn fodder for milch cows, two cows, "neither of them very good animals," were fed during four periods.

In all the periods the grain ration was the same, namely, 7.5 pounds of bran and 2.5 pounds of cotton-seed meal for each cow per day. During period 1 the coarse fodder consisted of the same rather poor quality of field-cured Burrill and Whitman corn fodder used in the previous experiment. The cows were fed as much of this as they would eat. In period 2 the corn fodder was replaced by coarse silage made from the same crop of corn which furnished the fodder. In period 3 the coarse silage was replaced by silage made from the same quality of corn, but shredded and weighted as described in the experiment on losses in the silo. In periods 2 and 3 the aim was to feed the same amount of dry matter as in period 1, and the differences in the amounts actually eaten were not very great. Period 4 was a duplicate of period 1, the corn fodder being fed in place of the silage of the two previous periods.

Data relative to the composition of the feeding stuffs used, the food and water consumed, the yield and composition of the milk, and live weight are tabulated.

As the result of averaging the two periods upon corn fodder and the two upon silage, the following general conclusions were arrived at:

As regards the total amount of milk produced, more was produced by the silage ration than by the fodder ration. The milk produced by the silage ration was more watery than that produced by the fodder ration, so that slightly more butter fat was produced by both cows and slightly more total solids by one cow upon the fodder ration than upon the silage ration.

As regards the milk produced per pound of food eaten, pound for pound of dry matter eaten, more milk and more milk solids were produced by both cows and more fat by one cow on the silage ration than on the fodder ration. Pound for

pound of digestible matter eaten, both cows produced less milk solids and milk fat and one cow produced less total milk on the silage ration than on the fodder ration. The greater efficiency of the dry matter of the silage ration was due to the greater digestibility of the silage. The greater yield of total milk per pound of digestible matter of the silage ration was due to the fact that the milk was more watery.

As regards the effect on the live weight, in Hepsie's case the silage ration produced a gain in live weight as compared with a loss on the fodder ration. In Durham's case the silage ration resulted in a loss of weight as compared with practically no loss on the fodder ration.

In view of the uncertainty attending the determination of the real gain of live weight and of the comparatively small differences observed, as well as of the fact that the difference is in the one case in favor of the fodder ration and in the other of the silage ration, we are, I believe, justified in drawing the general conclusion that the experiment failed to show any material advantage on the side of either the silage ration or the fodder ration, when silage and fodder were fed in corresponding quantities, other than that arising from a slightly greater digestibility of the silage as compared with the poorly cured corn fodder used.

The comparison of corn silage and roots for milch cows was made on two cows, a full-blood Jersey and a crossbred Guernsey Jersey, both new in milk. Both animals were fed a constant grain ration of 5 pounds of wheat bran and 2 pounds of cotton-seed meal daily, together with hay. In addition to this the cows were given silage *ad libitum* (about 40 pounds) from February 16 to March 8, and from March 8 to March 19 an amount of roots (sugar beets, mangel-wurzels, or rutabagas) furnishing an amount of dry matter equivalent to that in the silage, was substituted for the silage. The data obtained are tabulated, and the fluctuations in live weight are illustrated by a diagram.

On account of the short time roots were fed and the several kinds used, it is impossible to draw any final conclusions from the work. The results are published as being of much interest and as suggestive of the need of making similar trials under more advantageous circumstances. The conclusions drawn from this one trial are as follows:

(1) The live weight of the cows did not materially change, but there was a decided variation in the amount of food eaten daily when the two were on silage.

(2) More and richer milk was obtained from both animals while roots were fed, but at the same time a larger amount of digestible food was eaten.

(3) It took from 0.2 to 0.33 pound more digestible matter to produce 1 pound of milk solids, and from 0.068 to 1.94 pounds more to produce 1 pound of milk fat during the period when roots were fed than in the periods when silage was fed.

Yield of food per acre (pp. 118-123).—The yield is given of food ingredients in Burrill and Whitman corn per acre; losses in preservation; a comparison of the yields of food ingredients in corn and in hay; and remarks on the influence of variety and of maturity, and on the rational use of corn. "A good average corn crop has produced with us from one and one third to two and one quarter times as much food per acre as a good hay crop, or enough to support a cow in full flow of milk from 168 to 287 days."

General fertilizer experiments, W. H. Caldwell, B. S. (pp. 124-143).—This is a report of progress in a series of rotation experiments

with corn, oats, wheat, and grass, on four tiers of 36 eighth-acre plats. The experiment was commenced in 1881. The yields of corn, oats, wheat, and grass in 1890 on the respective tiers of plats are tabulated. Reports of this series of experiments have been printed in the Annual Reports of the Pennsylvania Agricultural College for 1882 and 1883, Bulletins Nos. 1, 2, 8, 9, 11, and 14 of the college and Annual Reports of the station for 1887, 1888, and 1889 (see Experiment Station Bulletin No. 2, part II, p. 132, and Experiment Station Record, vol. III, p. 461).

TESTS OF VARIETIES OF GRAIN, POTATOES, AND ROOT CROPS, 1890, W. H. CALDWELL, B. S. (pp. 144–157).—A report on tests of varieties of wheat, oats, potatoes, mangel-wurzels, and turnips. Accounts of similar tests in 1889 may be found in Bulletin No. 10 and the Annual Report of the station for 1889 (see Experiment Station Record, vol. II, p. 28, and vol. III, p. 453).

Wheat (pp. 144–149).—Notes and tabulated data on 26 varieties. The varieties especially commended are Dietz Longberry Red, Fulcaster, Currell Prolific, Deitz, Red Fultz, and Reliable. Fultz, German Emperor, and Raub Black Prolific "seem to be losing in quality."

Oats (pp. 149–151).—Notes and tabulated data on 15 varieties. "The Improved American and Japan varieties made the largest yield per acre and had good plump grain. Early Russian, Baltic White, and Wide Awake oats should be placed second on the list."

Potatoes (pp. 152–157).—Notes and tabulated data on 31 varieties.

From both this and previous years' trials it is found that the order of merit is practically the same whether based upon the farmer's general comparison (yield and general character of crop) or upon that of the yield of valuable food material (dry matter) per acre. * * *

Taking the general characteristics and yield into consideration, the following are the varieties recommended as yielding over 125 bushels of merchantable tubers per acre: Burbank Seedling, Monroe County Seedling, Burpee Superior, Rural New Yorker No. 2, and White Elephant of those that have been grown here for 1 or 2 years, and the Green Mountain, Ben Harrison, and Seneca Beauty of the newer varieties tested.

Monroe County Prize, Dakota Red, College White, Arthur Memorial, Ross Favorite, and Vanguard of the varieties grown here before, and New Burbank and Ironclad of those introduced this season, yielded from 100 to 125 bushels per acre and were of good quality, and could be classed as safe varieties to plant.

One noticeable feature in this season's work is the extremely low yield of the early varieties--Hampden Beauty, Beauty of Hebron, Early Ohio, Early Puritan, Early Sunrise, Polaris, and June Eating, all except the latter (which was introduced this year) having been successfully grown here in past seasons. This is no doubt mainly due to the extreme wetness of the ground until July and the excessive drouth following in July and August.

Mangel-wurzels and turnips (p. 157).—Brief tabulated data for 4 varieties.

TESTS OF VARIETIES OF VEGETABLES, G. C. BUTZ, M. S. (pp. 158–165).—A reprint of Bulletin No. 14 of the station (see Experiment Station Record, vol. II, p. 607).

Black knot of plums, G. C. Butz, M. S. (pp. 166, 167, plate 1).—This article was also published in Bulletin No. 13 of the station (see Experiment Station Record, vol. II, p. 606).

A few ornamental plants, G. C. Butz, M. S. (pp. 167–169, plate 1).—This article was also published in Bulletin No. 13 of the station (see Experiment Station Record, vol. II, p. 606).

Simple methods of determining milk fat, W. Frear, Ph. D., and G. L. Holter, B. S. (pp. 172–187).—A reprint of an article in Bulletin No. 12 of the station (see Experiment Station Record, vol II, p. 294).

Dried brewers' grains, W. Frear, Ph. D. (pp. 188, 189).—A reprint of an article in Bulletin No. 12 of the station (see Experiment Station Record vol. II, p. 295).

Comparative tests of methods for determination of total phosphoric acid in samples containing organic matter, J. A. Fries (pp. 190–192).—A comparison was made on a number of organic materials containing phosphoric acid of dissolving the phosphoric acid (1) in nitric and hydrochloric acids, (2) by digesting with sulphuric acid and adding small quantities of potassium nitrate, (3) by igniting with magnesium nitrate and dissolving in nitric and hydrochloric acids, and (4) by igniting with the addition of silica and dissolving in nitric and hydrochloric acids. "Igniting the sample mixed with powdered silica before dissolving has proved to be the most reliable in the presence of organic matter."

Meteorology, W. Frear, Ph. D. (pp. 193–210 and 217–265).—The work in 1890 was along the same lines as that reported in the Annual Reports of the station for 1888 and 1889 (see Experiment Station Bulletin No. 2, part II, p. 139, and Experiment Station Record, vol. III, p. 464), and included observations on atmospheric phenomena, amount of sunshine, soil temperatures, and soil moisture. Monthly summaries of the meteorological observations and weekly crop reports are given in the body of the Report and the detailed record of daily observations in an appendix.

The results of the observations on soil moisture are recorded in the following table:

Soil moisture.

Date.	Intervening rainfall.	Days since last rain.	Moisture in soil.	Date.	Intervening rainfall.	Days since last rain.	Moisture in soil.
	Inches.		*Per cent.*		*Inches.*		*Per cent.*
April 11	(*)	3	22.70	July 25	0.46	0	13.96
April 25	0.31	0	20.83	August 1	0.04	6	7.14
May 2	0.99	1	21.46	August 15	1.82	5	9.46
May 9	1.50	3	22.04	August 22	1.38	0	15.31
May 16	1.60	3	20.83	September 5	2.26	7	14.61
May 23	2.07	0	23.30	September 12	0.85	6	13.75
June 13	2.65	1	16.20	September 19	0.71	2	20.86
June 20	0.19	5	15.58	September 26	0.53	0	27.83
June 27	0.16	5	8.27	October 3	0.66	0	21.63
July 5	1.44	1	18.00	October 10	0.61	3	19.59
July 11	0.25	2	13.81	October 17	1.18	0	23.90
July 18	1.15	3	17.49				

*1.61 inches within the preceding 5 days.

From June 1 to the middle of September the average soil moisture was several per cent less than that of the same soil at the same period last year. The drouth this year was very considerable, as is shown by the weekly crop reports presented in a later table. As in 1889, the percentages of moisture were much lower than those of 1888. As last winter was also an open one, it still remains to be seen whether the difference in the absorptive power and retentiveness of the soil for moisture produced by the freezing of a severe winter, is sufficient to explain the observed variation.

The following is the yearly summary of meteorological observations:

Summary of meteorological observations.

	Year 1890.	Winter (October, 1889, to March, 1890).	Growing season (April to September, 1890).
Barometer (inches):			
Mean	30.02		
Highest	30.67 (Jan. 22)		
Lowest	29.23 (Oct. 29)		
Temperature (degrees F.):			
Mean	49.26	37.9	61.9
Highest	94 (July 8)		94 (July 8).
Lowest	—6 (Mar. 7)	—6 (Mar. 7)	32 (Sept. 25).
Annual range	100		
Mean daily range	18.27		20.9
Greatest daily range	41 (Apr. 12)		41 (Apr. 12).
Least daily range	3 (Oct. 13)		
Mean daily relative humidity (per cent).	78.24		73.6
Rainfall (inches):			
Total	43.88	23.87	23.05
Greatest monthly	6.77 (May)		
Greatest daily	1.46 (Oct. 21)		1.32 (May 18).
Number of days on which 0.01 inch or more of rain fell:	158		76
Mean percentage of cloudiness	61.62		51.9
Number of days on which cloudiness averaged 80 per cent or more.	163	96	59
Average hours of sunshine per day.			7h. 13m. (Apr. 12, to Sept.).
Wind (miles):			
Total movement	37,754		
Maximum velocity	32 (Jan. 27)		
Greatest daily movement	459 (Dec. 12)		
Last frost in spring			May 18.
First frost in fall			Sept. 25.

Soil temperatures in degrees F., April to September, 1890.

	At surface.	Below surface.	
		1 inch.	3 inches.
Highest	94 (July 8 and 15)	87 (July 8)	83 (Aug. 3).
Lowest	31 (Apr. 2)	31 (Apr. 2)	33.5 (Apr 2).
Daily mean	62.3	61.2	62.1
Mean daily range	12.2	9.4	7
Greatest daily range	29 (Apr. 3)	19 (Apr. 3, July 2)	18 (June 3).

	Below surface.		
	6 inches.	12 inches.	24 inches.
Highest	79.5 (July 8)	77 (Aug. 4)	72 (Aug. 5).
Lowest	35 (Apr. 1 and 2)	35 (Apr. 1 and 2)	36 (Apr. 1 and 2).
Daily mean	62	61.6	59.7
Mean daily range	4.4	1.8	0.3
Greatest daily range	11.5 (July 11)	4.5 (Apr. 3)	2 (Aug. 2).

Principal periods of crop development.

Wheat:
- Headed May 30–June 6.
- Ripened June 27–July 4.
- Harvested July 11–18.

Corn:
- Planted May 16–30.
- Cut September 19–26.

Oats:
- Sown April 11–18.
- Ripened July 18–25.
- Harvested August 1.

Hay:
- Harvested June 27–July 11.

The winter of 1889–90 was mild and open, spring set in early, and growth was well started when cold nights and rains followed and materially retarded the development of spring grains and planting of corn and potatoes, while late frosts completely ruined the large-fruit crop and grapes. The unfavorable conditions of growth at this early stage seriously impaired the power of oats and barley to resist the attack of the parasite whose ravages were so widespread. The rains at this season also lodged the wheat to some degree, but not sufficiently to seriously damage it. Sunny weather after corn planting was very beneficial to this crop as well as to the early growth of potatoes. Hay harvest was marred by frequent and heavy showers, which damaged a great deal of the product. After this a season of drouth occurred, which greatly damaged the corn and the potatoes. The abundant rains during the latter part of August were beneficial, but too late to fully compensate for the earlier damage. Owing to their influence, the earlier varieties of potatoes rotted badly, but the later varieties were considerably improved. The weather in September was quite favorable to the young wheat, but too rainy and cloudy for the best curing of corn or the best harvesting of potatoes and other root crops.

Pennsylvania Station, Bulletin No. 18, January, 1892 (pp. 16).

New and old varieties of orchard and small fruits, G. C. Butz, M. S. (figs. 4).—This includes notes on pears, apples, plums, strawberries, raspberries, blackberries, currants, and grapes.

Pears.—Descriptive notes on 28 varieties grown in an orchard planted in 1886 on deep, rich clay soil. The varieties derived from the Chinese Sand pear were noticeable for their healthy foliage.

Apples.—Tabulated data for 26 varieties planted in 1889–91 in the station orchard.

Plums.—Tabulated data on 22 varieties planted in 1886, which yielded their first crop of fruit in 1891.

Strawberries.—Tabulated data and descriptive notes on 13 varieties. Crescent, Greenville, Van Deman, Charles Downing, and Kentucky gave the largest yields.

Raspberries.—Tabulated data for 15 varieties. Caroline and Shaffer Colossal gave large and uniform yields and were very slightly affected by rust.

Blackberries.—Tabulated data for 8 varieties. Early Harvest and Snyder gave the largest yields and are recommended as being hardy and requiring relatively little attention.

Currants.—Yields of 7 varieties are reported, the largest being White Grape.

Grapes.—Brief descriptive notes on 10 varieties. "No better all-round good grape for Pennsylvania than the Concord" has been found. Moore Early is recommended for an early grape.

South Carolina Station, Fourth Annual Report, 1891 (pp. 12).

This is a report of the operations of the station for the first year since it became a department of the Clemson Agricultural College at Fort Hill, and consists of general statements regarding the organization, equipment, and work of the station; a financial statement for the fiscal year ending June 30, 1891; and the text of the act of Congress of March 2, 1887, and of acts of the State legislature relating to the station.

Tennessee Station, Bulletin Vol. V, No. 1, January, 1892 (pp. 28).

EXPERIMENTS WITH ORCHARD FRUITS, GRAPES, AND VEGETABLES, R. L. WATTS, B. AGR. (plates 3).—*Experiments with orchard fruits and grapes.*—Tabulated data showing the growth of apple trees of 43 varieties planted in the station orchard 4 years ago. A vineyard, including 76 varieties of grapes, has been planted for experimental purposes. A list of the varieties of apples, pears, peaches, grapes, plums, and cherries which have been found adapted to different sections of Tennessee, is given from replies to a circular of inquiry sent out by the station to fruit growers. Previous reports regarding orchard fruits may be found in Bulletins vol. III, No. 5, and vol. IV, No. 1, of the station (see Experiment Station Record, vol. II, p. 426, and vol. III, p. 42). The following summary is taken from the bulletin:

(1) The best apples for Tennessee are usually of Southern origin.

(2) The number of apples grown in Tennessee which originated farther north is comparatively small.

(3) The two most extensively grown and perhaps the finest winter apples are Limber Twig and Winesap.

(4) Early Harvest, Red June, Horse, and Summer Rose are the most popular summer varieties.

(5) Fall Queen, Ben Davis, Maiden Blush, Kinnard Choice, Shockley, and Buckingham are the best for autumn use in most localities.

(6) There are many seedling fruits in Tennessee, the names of which are unknown, that are good varieties and should be largely disseminated.

(7) The number of pears in cultivation is limited to Le Conte, Keiffer, Bartlett, Seckel, Clapp Favorite, Belle, Duchess, Flemish Beauty, Duchesse d'Angouleme, and a few others.

(8) The native seedling peaches receive the most attention. Good cultivated varieties are Crawford Early and Late, Heath, Indian, Snow, Stump the World, and Mountain Rose.

(9) The Concord grape is adapted to most localities. Other varieties reported as doing well are Ives, Moore Early, Diamond, Scuppernong, Catawba, Delaware, Lutie, Norton Virginia, and Martha.

(10) The Wild Goose plum is superior in all parts of the State.

(11) Early May is the most popular cherry. Governor Wood, Black Heart, Early Richmond, and May Duke are reported as good varieties.

Experiments with vegetables.—Descriptive notes, and in some cases tabulated data, are given for 14 varieties of beans, 7 of beets, 14 of cabbages, 6 of lettuce, 11 of muskmelons, 19 of watermelons, 7 of peas, 7 of radishes, 6 of sweet corn, and 5 of tomatoes. There are also accounts

of experiments in the forcing of lettuce in a greenhouse and in the culture of early cabbages. The following varieties of vegetables are especially commended:

Beans—bush varieties.—Improved Early Red Valentine, Extra Early, Wardell Wax, and Golden Wax; *pole varieties.*—King of the Garden, and Dreer Improved.

Cabbages—early.—Early Wakefield, Large Early Wakefield, Early Flat Dutch, Early Summer, and Landreth Earliest; *late.*—Etampes, Burpee All Head, Nonesuch, and All Seasons.

Lettuce.—Black-Seeded Simpson, Early Curled Simpson, Early Curled Silesia, Hanson, Sugar Loaf, and Grand Rapids.

Muskmelons.—"Netted Pineapple, Montreal Market, Hackensack, and Golden Jenny were finely flavored. New Giant produced the largest specimen, which weighed 12.75 pounds."

Watermelons.—"The largest melon, a 40-pound one, was cut from a variety called Boss. Striped Gypsy and Ironclad each produced one that weighed 39 pounds. All of these melons possess good flavor and are excellent market varieties. The best-flavored ones were Mountain Sweet, Green and Gold, and Dark Icing. Pride of Georgia, Cuban Queen, Striped Gypsy, Boss, and Scaly Bark are all standard melons."

Peas—early.—Extra Early Pioneer, Improved Daniel O'Rourke, Tom Thumb, Lightning, Stratagem, Dreer Eureka, and Extra Early; *late.*—McLean Advance, and Dwarf Blue Imperial.

Radishes.—Wood Early Frame, Round White Forcing, Round Red Forcing, Cardinal Globe, White Box, Salzer Twenty Day Forcing, and Early French Breakfast.

Sweet corn.—Egyptian, Little Gem, Triumph, and Roslyn Hybrid.

Tomatoes.—Golden Queen, Yellow and Red Pear, Dwarf Champion, Livingston Favorite, Cardinal, Livingston Perfection, Optimus, Ignotum, and Paragon.

Texas Station, Fourth Annual Report, 1891 (pp. 13).

This includes brief statements regarding the work of the several divisions of the station and an index to the station publications for 1891.

Meteorology.—Monthly and yearly summaries of observations are given for 1889, 1890, and 1891. The yearly summary for 1891 is as follows: *Pressure* (inches).—Mean 29.7. *Air temperature* (degrees F.).—Maximum 100, minimum 25, mean 66.13. *Precipitation* (inches).—Total 42.28. *Wind.*—Prevailing direction, south.

Texas Station, Bulletin No. 18, October, 1891 (pp. 14).

LIVER FLUKES, M. FRANCIS, D. V. M. (pp. 127–139, plates 8).—Illustrated descriptions of *Distomum hepaticum* and of another species which the author proposes to call *D. texanicum.* This latter species, however,

has since been shown by C. W. Stiles to be identical with *Fasciola americana*, Hassall, which is probably the same as *D. magnum*, described some years ago by Bassi (see Experiment Station Record, vol. III, p. 580). The description of this parasite, given in the bulletin, is as follows:

Body flat, liver-colored, elliptical or oval, some wider behind than in front, adults 30 to 35^{mm} long and 20 to 30^{mm} wide. Some very large ones 73^{mm} long; smallest ones 8^{mm} long and 4^{mm} wide; the average specimens about 30^{mm} long. Skin of small and medium-sized ones armed with numerous spines, or points, directed backward. Mature specimens destitute of spines, except in patches or scattering ones, especially on ventral surface of body, near the outer margin, and then generally large. Mouth terminal, sessile, not on a well-defined neck. Ventral sucker large, muscular, 4 to 5^{mm} from preceding. Genital pore midway between the preceding. Penis not always protruding, but when so, curved slightly. Excretory pore small, at opposite extremity from mouth and slightly dorsal. The margin here is sometimes curved from both sides, making it slightly obcordate. Eggs brown, oval or a little larger at one end, on which there is the cap; length from 0.14 to 0.16^{mm}; width 0.09 to 0.1^{mm}. The digestive tract consists of the mouth, which is made up of circular and radiating muscular fibers, in which are situated, in each section, four or five large nucleated cells. From the mouth proceeds a muscular pharynx, which suddenly divides, a little anterior to the genital pore, into two main trunks, which extend the entire length of the body. These give off from twelve to sixteen branches, which give off secondary ones, which terminate in blind pouches or cæca. The lining of the digestive tract is disposed in finger-like points or projections, somewhat similar to the villi of mammals. This parasite is found in the liver tissue of cattle. I have found as many as twenty-seven in one liver. The average number is from ten to fifteen. These parasites are found in channels which they have produced. They seem to wander aimlessly about in any direction. I think the majority are near the convex or outer surface of the liver. The channels they produce admit the little finger, and these seem to heal or fill up soon after, leaving a red scar. Sometimes they perforate the surface of the liver, then suddenly turn back into the liver again. I think that they sometimes leave the liver and bore into adjoining tissues or organs, but I have not found them in other places than the liver. Having wandered about for some time they come to rest and encyst themselves. Frequently two have encysted together. Those that are wandering have their bodies covered with spines, while those at rest seem to have lost their spines—organs of locomotion. When encysted they are always sexually mature. The wall of the cyst becomes dense and tough and is usually coated with a gritlike substance. Butchers call such livers "shelly." I think they die in these cysts. These cysts contain a very dark (almost black) muddy liquid, which contains myriads of eggs. The gall and gall bladder of such livers are usually normal, and in several instances in which I examined the entire quantity of bile a very few eggs were found. I think the greatest number was five in the entire quantity of bile, and I was not positive as to these being the eggs of this animal.

Texas Station, Bulletin No. 19, December, 1891 (pp. 7).

CORN FODDER, G. W. CURTIS, M. S. A. (pp. 153–159).—To compare the effect on the yield of shelled corn and of dry cured fodder of topping, pulling, topping and pulling, and allowing the whole plant to field-cure naturally, the corn on 4 different plats received the following treatment:

"Plat No. 1, tops cut above ears, leaving blades on stalks below; Plat No. 2, left without touching until ripe and thoroughly dead; Plat No. 3, leaves stripped from entire stalk for fodder, leaving only the stalks and ears standing; Plat No. 4, tops cut above the ears, and leaves pulled below, leaving only the naked stalk up to and including the ear."

The plats were all manured alike and received the same general treatment. Dry weather diminished the yield "at least one third in each case." The yield and composition of the shelled corn, the calculated nutritive ratios of the fodders, and the financial results are tabulated. The yield of shelled corn from the 4 plats was 17.45, 17.22, 15.9, and 16.07 bushels per acre, respectively, and there was only a slight difference in its composition. The yield of tops from plat 1 was 1,093 pounds (cost per ton $2.13); of leaves from plat 3, 427 pounds (cost per ton $7.67); and of leaves and tops from plat 4, 1,367 pounds per acre (cost per ton $2.25). The yield of whole fodder from plat 2 is not given. The leaves proved the richest fodder, as is indicated by the following analyses:

Fodder from different parts of corn plant.

	Tops only, taken from plat 1.	Leaves only, taken from plat 3.	Tops and leaves, together, taken from plat 4.
	Per cent.	*Per cent.*	*Per cent.*
Protein	11.377	14.031	12.103
Fat	2.655	2.665	2.460
Crude fiber	27.580	26.640	26.750
Carbohydrates	41.936	37.254	42.967
Ash	8.175	12.240	8.200
Water	8.475	7.170	7.520

So far as the cost of gathering and storing fodder is concerned, there can be no question that saving fodder in any one of the three ways mentioned is a profitable practice. Counting cost in each case and the value of the different fodders, and especially the effect on yield of corn of the different plans of gathering fodder, the practice of pulling leaves only will be found unprofitable as compared with cutting tops only, or cutting tops above and pulling leaves below the ears. Of the two latter plans we have come to the conclusion that it is more profitable, one year with another, to cut tops only.

[Regarding the time for topping or pulling, it is recommended to] let the corn stand until the ears are well hardened—never mind if the lowest leaves are even turning dry and yellow—as late as possible, so that the fodder is saved, while the upper leaves, stalk, and the outer husks of the ear are still green. * * *

In conclusion, we would say to all farmers in this section of the country: Do not neglect to save what fodder is made in growing corn, and grow at least enough corn to supply what fodder is really needed for the stock kept on hand.

Washington Station, Bulletin No. 2, January, 1892 (pp. 20).

REPORT OF FARMERS' INSTITUTE AT COLTON, WASHINGTON (pp. 21–36).—This includes papers on the following subjects read by members of the station staff at the farmers' institute held at Colton, Washington,

January 30, 1892: The Purposes and Aims of the Washington Agricultural College, by G. Lilley, LL. D.; Dairy Farming in Washington, by J. O'B. Scobey, M. A.; The Tree Crop for Eastern Washington, by E. R. Lake, M. S.; and Spasmodic and Flatulent Colic, by C. E. Munn, V. S.

Wyoming Station, Bulletin No. 5, February, 1892 (pp. 40).

THE BEST CROPS AND LIVE STOCK FOR WYOMING, D. McLAREN, M. S., AND B. C. BUFFUM, B. S. (pp. 139-176).—Suggestions regarding the varieties of field crops, vegetables, and fruits, and the breeds of live stock which are best adapted to the different sections of the State, as determined by tests at the farms of the station and from replies to circulars of inquiry.

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF STATISTICS.

Report No. 93 (new series), March, 1892 (pp. 45–92).—This includes articles on distribution and consumption of corn and wheat, notes from reports of State agents, overproduction of cotton, European crop report for March, estimated wheat crop of the world in 1891, official statistics of foreign countries, and transportation rates.

The commercial supply of cotton produced in this country, in India, Egypt, and Brazil, as reported by Ellison, was a little more than 8,000,090 bales of 500 pounds each in 1882, over 10,000,000 in 1888, and over 12,000,000 in 1890, while the consumption of Europe and the United States was 8,430,100 for the 6 years from 1886 to 1891, and the estimated consumption of India was 1,000,000 bales, making a consumption of 9,430,100 bales. It is seen that increasing consumption prevented a glut until the crop of 1890 was sent to market. * * *

These facts show clearly what is the matter with cotton growing. It is suffering from overproduction. In the last 2 years this country has produced more than 2,000,000 bales above the requirements of consumption. It has reduced prices to a point which planters declare is below cost of production.

What is the remedy? It is quite as easily indicated as the diagnosis of the disease is accurate. Reduce the area in cultivation. This is easily said, but it can only be done with difficulty. * * *

Something must be done, however, or agriculture in the South will suffer worse than it ever has in the West. The cotton crop, now worth on the plantation scarcely $300,000,000, will not suffice to support 11,000,000 people of the ten cotton States south of Virginia. A product yielding $22 per head will neither enrich nor feed a people. Of course only three fourths of this population are engaged in agriculture, and not all are growing cotton. But more crops must be grown. It is suicidal to bring hay into a purely agricultural country, to buy flour where the labor that would produce it is wasted, to go to the West for meats when they can be produced cheaper than in the West. This is not all. Not only should these States be self-supporting, but they should produce a larger part of the sugar now imported, and save millions of dollars in fibers now brought from Mexico and Yucatan, from China and the East Indies. The bananas and pineapples of the tropics, now very remunerative to south Florida cultivators, could be multiplied a hundredfold, and many other fruits in proportion.

The wheat crop of the world in 1891, leaving out Bulgaria and Caucasus, is estimated at 2,238,245,081 bushels, as compared with 2,203,889,552 bushels in 1890. The United States produced 611,780,000 bushels.

BUREAU OF ANIMAL INDUSTRY.

Sixth and Seventh Annual Reports, 1889 and 1890 (pp. 503).—These include general statements and statistical information regarding the work of the Bureau, relating especially to pleuropneumonia, Texas fever, hog cholera, swine plague, glanders, and the inspection of cattle for export and import, by the chief of the Bureau, D. E. Salmon; accounts of scientific investigations of Texas fever, swine plague, and hog cholera, by T. Smith and E. A. Von Schweinitz; report of the U. S. board of inquiry concerning epidemic diseases of swine, by E. O. Shakespeare, T. J. Burrill, and B. M. Bolton; breeds of sheep in Great Britain, by E. A. Carman; condition of the sheep industry west of the Mississippi River, by H. A. Heath; condition of the live stock industry of Wisconsin, by S. W. Campbell; the Chicago Horse Show of 1890, by G. A. Martin; reports from inspectors and correspondents on an outbreak of a cutaneous disease among cattle, diseases among swine, splenic or Texas fever, anthrax or charbon, pneumonia among horses, condition of the live stock industry of Nebraska, deterioration of American cheese, horse breeding in New Jersey, outbreak of disease among cattle in Missouri, glanders among horses and mules in Texas, regulating the transportation of Southern cattle, and pleuropneumonia in Great Britain, Scotland, and Ireland; condition of the animal industry of Kansas, by H. A. Heath; condition of the live stock industry of Colorado and Wyoming, by J. F. M. McNeely; exhibition of the Vermont Trotting Horse Breeders' Association, by H. Romaine; infectious abortion of mares, by W. L. Williams; and laws of the States and Territories for the control of contagious diseases of domestic animals.

DIVISION OF FORESTRY.

Bulletin No. 6.

Timber physics, part i, B. E. Fernow (pp. 16).—This is the introductory portion of "the first of a series of bulletins which are to record the results of an extensive investigation into the nature of our important woods, especially their mechanical and technical properties, and the dependence of these upon structure and physical condition, and upon the conditions under which the wood has grown." Bulletin No. 6 will be preliminary in character and will discuss the need, object, and scope of the investigation; give references to previous work in this line; and explain the methods employed in the present investigation, including the forms of record and illustrations of the machinery in use. This portion of the bulletin contains general statements regarding the need of the investigation and abstracts of letters from scientific societies, engineers, and other persons, showing the usefulness of such work under direction of this Department.

This investigation, the most comprehensive of the kind ever undertaken anywhere, in this country or in Europe, differs from all former attempts in a similar direction in this, that it starts out with the fullest recognition of three facts·

(1) That in order to establish reliable data as to mechanical properties of our timbers, it is necessary to make a very large number of tests, by which the range as well as average capabilities of the species is determined.

(2) That in order to enable us to make the most efficient practical application of the data thus obtained, it is necessary to know the physical and structural conditions of the test material and bring these into relation with the best results.

(3) That in order further to deduce laws of relation between mechanical properties and the physical and structural conditions, as well as the conditions under which the material was produced, it is necessary to work on material the history of which is thoroughly known.

Briefly, then, to solve the problems before us it is necessary to make our test on a large number of specimens of known origin and known physical condition. While the tests in themselves appeal at once and first to the engineer, inasmuch as by their great number they will furnish more reliable data regarding the capabilities of the various timbers, the chief value and most important feature of the work lie in the attempt to relate the mechanical properties to the structure of the material and to the conditions under which it was produced.

The organization and methods of the investigation have been briefly described in Circular No. 7 of the Division, as follows:

There are four departments necessary to carry on the work as at present organized, one for each of the following lines of work: (1) Collecting, (2) mechanical tests, (3) physical and microscopic examination of the test material, and (4) compilation and final discussion of results.

The collection of the test material is done by experts (Dr. Charles Mohr of Mobile, Alabama, for Southern timbers). The trees of each species are taken from a number of localities of different soils and climatic conditions. From each site five trees of each species are cut up into logs and disks, each piece being carefully marked, so as to indicate exactly its position in the tree; four trees are chosen as representative of the average growth, the fifth or "check tree" being the best-developed specimen of the site.

Disks of a few young trees, as well as of limb wood, are also collected for biological study. The disk pieces are 8 inches in height and contain the heart and sapwood of the tree from the north to the south side of the periphery. From fifty to seventy disk pieces and from ten to fifteen logs are thus collected for each species and site.

A full account of the conditions of soil, climate, aspect measurements, and determinable history of tree and forest growth in general accompanies the collection from each site.

The disks are sent, wrapped in heavy paper, to the botanical laboratory of the University of Michigan at Ann Arbor (Mr. F. Roth, in charge), to be studied as to their physical properties, macroscopic and microscopic structure, rate of growth, etc. Here are determined (1) the specific weight by a hygrometric method; (2) the amount of water and the rate of its loss by drying in relation to shrinkage; (3) the structural differences of the different pieces, especially as to the distribution of spring and summer wood, strong and weak cells, open vessels, medullary rays, etc.; (4) the rate of growth and other biological facts which may lead to the finding of relation between physical appearance, condition of growth, and mechanical properties.

The material thus studied is preserved for further examinations and tests as may appear desirable, the history of each piece being fully known and recorded.

The logs are shipped to the St. Louis Test Laboratory, in charge of Prof. J. B. Johnson. They are stenciled off for sawing and each stick marked with dies, corresponding to sketch in the record, so as to be perfectly identified as to number of tree, and thereby its origin, and as to position in tree. After sawing to size, the test pieces are stacked to await the testing. One half of every log will be tested green, the other half after thorough seasoning. At the time of testing a determination

is made of the amount of water present in the test piece, since this appears to greatly influence results.

From each tree there are cut two or three logs and from each log three or four sticks, two of standard size, the other one or two of larger size. Each standard stick is cut in two, and one end reserved for testing 2 years later, after seasoning. The standard size for the sticks is 4 by 4 inches and 60 inches long for cross-breaking tests. However, there will be made a special series of cross-breaking tests on a specially constructed beam-testing machine, gauged to the Watertown testing machine, in which the full log length is utilized with a cross section of 6 by 12 up to 8 by 16 inches, in order to establish the comparative value of beam tests to those on the small test pieces. It is expected that on an average fifty tests will be made on each tree, besides four or five beam tests, or two hundred and fifty tests for each species and site. The methods adopted for the tests will be described more fully later.

All due caution will be exercised to perfect and insure the accuracy of methods, and besides the records, which are made directly in ink into permanent books, avoiding mistakes in copying, a series of photographs, exhibiting the character of the rupture, will assist in the ultimate study of the material, which is also preserved.

The department of compilation and final discussion of results is as yet not organized.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

The assimilation of free atmospheric nitrogen by plants in its relation to species, supply of plant food, and kind of soil, B. Frank (*Landw. Jahrb., 21 (1892), pp. 44*).—In this paper the author reviews investigations made by himself in recent years, on the part which the free nitrogen of the atmosphere plays in plant economy, as influenced by species of plant, by supply of plant food in the soil, and by the kind of soil. With reference to the first point he cites experiments with cryptogamous plants (*Penicillium*, pure cultures of tubercle bacteria, and algæ), which go to show that these organisms are capable of growing and accumulating nitrogen in an atmosphere freed from ammonia compounds and on a nitrogen-free substratum, and that algæ enrich the soil in nitrogen derived from the air; and with phænogamous plants (oats, buckwheat, spurry, rape, and yellow lupine *), indicating that these plants, non-leguminous as well as leguminous, can derive nitrogen from the atmosphere, provided they are furnished with sufficient phosphoric acid, potash, and lime, although it is not denied that non-leguminous plants are benefited by nitrogenous manures. "It is reasonable to suppose that in a soil rich in nitrogenous compounds the plants make less effort to secure nitrogen from the air than where this latter source is the only one. It may be assumed that the plant assimilates the nitrogen of nitrogenous compounds more readily than the nitrogen of the atmosphere." This leads to the question of the effect of the supply of plant food on free nitrogen assimilation. The author studied this in experiments with yellow lupine and peas grown (1) without nitrogenous manures but inoculated, and (2) with applications of calcium nitrate, ammonium sulphate and urea, respectively, both with and without inoculation. He sums up the conclusions of these tests as follows: It is possible for yellow lupine and peas to develop without the aid of the symbiosis when manured with nitrates, ammonia, or urea; but the symbiosis alone (without nitrogenous manuring) gives better results with both kinds of plants than nitrogenous manures alone (without inoculation). When the above nitrogenous manures were used in conjunction with the inoculation, the manures appeared to act disadvantageously in the case of the lupine plants, but to be of benefit to the peas.

* See Experiment Station Record, vol. III, p. 418.

The experiments as to the relation of kind of soil to the assimilation of nitrogen were made with rape and oats grown in sand and loam; and with lupine, peas, and red clover grown in sand, humus soil, and moor soil, variously fertilized. Parallel experiments were made in all cases, one set of plants being inoculated and another uninoculated. The results of this series of experiments are given, together with the summary of those relating to species and plant food supply, in the following general conclusions, which are by the author:

(1) All plants, non-leguminous as well as leguminous, can utilize the free nitrogen of the air; in other words, a greater or less part of the nitrogen contained in the harvested crop has been derived by the plant from the air. The assimilation of free atmospheric nitrogen is a physiological function of all plants, without regard to class or order.

(2) While the combined nitrogen of the soil is not to be altogether ignored, its importance in the cultivation of plants differs widely with different kinds of plants.

(3) So far investigations have pointed to only one plant, namely, the yellow lupine, which when inoculated with its special tubercle microbes and grown in soil free from or poor in nitrogen, yields a larger amount of nitrogen in the harvested crop without nitrogenous manures than with them. That is to say, in the case of this plant grown on light soil the symbiosis alone is more effectual in inducing nitrogen assimilation than the symbiosis and nitrogenous manures used together. The latter appear to diminish the ability of the plant to acquire atmospheric nitrogen, and hence are a direct waste.

(4) The pea, on the contrary (and probably many other Leguminosæ), gives the maximum yield of nitrogen when nitrogenous manures, especially nitrates, are applied in addition to the symbiosis. The quantity of nitrate required, however, is less than has usually been supposed necessary.

(5) The yellow lupine is out of place on rich soils, as with the symbiosis it yields less nitrogen there than when grown on soils poor in nitrogen.

(6) Peas, red clover, and probably many other Leguminosæ yet to be tested obtain more nitrogen from the air when grown on rich humus soils than when grown on lighter soils, even though the latter be manured with sufficient phosphoric acid and potash. Since the nitrogen in the soil seems to be a controlling factor in the case of these plants, it is a question whether rich soils require nitrogenous manures for these crops.

(7) The stubble and roots of leguminous plants enrich the soil in nitrogen to a far greater degree than those of non-leguminous plants, especially in proportion to the amounts of nitrogen which they derive from the soil. The latter, however, take a part of their nitrogen from the air and their effect in enriching the soil is seen if the whole plant is returned to the soil. This effect is more prominent the better adapted the soil is to the crop and especially if a supply of readily available nitrogenous fertilizer is furnished during the earlier stages of growth.

(8) Both leguminous and non-leguminous plants agree in that the reserve supply of nitrogen in the seed is insufficient to supply the young plant until it reaches the stage where it can assimilate sufficient nitrogen from the atmosphere, and unless nitrogen is furnished to bridge over this interval nitrogen hunger ensues.

(9) In the case of non-leguminous plants the nitrogen hunger is avoided by applying sufficient nitrogenous fertilizer to the soil to enable the plant to reach the stage where it can assimilate atmospheric nitrogen. In leguminous plants, however, this younger stage is provided for by the presence of certain bacteria which render atmospheric nitrogen available to plants of this order during this stage of development. These bacteria render leguminous plants independent of combined nitrogen.

(10) Nitrogen assimilation occurs in non-leguminous plants without the aid of microbes, and these are not absolutely essential in leguminous plants, for if the

latter be nourished through the younger stages from the soil, they, like the non-leguminous plants, can fix free nitrogen without the aid of these organisms later. With most leguminous plants, however, the symbiosis with these organisms enables a more extensive assimilation.

(11) The hypothesis becomes more probable, that the action of this symbiosis lies more in the plants themselves than in the bacteria; that is, that the bacteria by their presence act as a stimulus to the plant, rendering its inherent ability for nitrogen assimilation more active.

Investigations on the adherence to the foliage of potato plants of compounds of copper used for controlling plant diseases, A. Gérard (*Compt. rend., 114 (1892), pp. 234–239*).—Observing the injury to the potato crop by rot (*Phytophthora infestans*) in 1890, due to the excessive rains washing the fungicides from the foliage and thus allowing the parasites to develop unchecked, the author was led to institute a series of experiments to test the persistency with which the various copper mixtures which have been proposed for controlling plant diseases adhere to the foliage.

For this purpose potato plants growing in large pots in a plant house were treated in different cases with Bordeaux mixture (ordinary, with one half quantity of lime, and with addition of alum), copper-soda solution, copper-lime saccharate (copper sulphate 4.4 pounds, lime 4.4 pounds, molasses 4.4 pounds, water 26 gallons), and verdigris (bibasic acetate of copper) solution. The sprayed plants in each case were divided into 3 lots, which were sprinkled with water by means of an apparatus specially devised for the purpose, as follows: (1) For 22 minutes at a rate corresponding to a rainfall of 17 mm.; (2) for 6 hours at a rate corresponding to a rainfall of 15 mm.; and (3) for 24 hours at a rate corresponding to a rainfall of 10 mm. One half of the plants of each lot were afterwards gathered, dried, and subjected to analysis to determine the proportion of copper adhering to them. The results showed wide variations as regards the different treatments. The Bordeaux mixture appeared to be more readily washed off than any of the other compounds, but lessening the proportion of lime or adding alum produced no sensible improvement. Copper soda and verdigris solution showed powers of adherence almost double that of the Bordeaux mixture, while the copper-lime saccharate was not washed off at all, except in the case of violent sprinkling. The author concludes that of the last three solutions convenience alone must determine the choice.

Contribution to the study of the development of cereals, A. Hébert (*Ann. Agron., 18 (1892), pp. 33–47*).—Analyses of wheat and oat plants in different stages of development made at the Grignon Station by the author, Dehérain, and others during a number of years past, are tabulated and discussed. During the period immediately after germination the whole of the vital activity of plants is devoted to the development of their root systems. This explains why the assimilation of nitrogen and mineral matter is most active at that period, as shown by

the analyses reported. Tabulated data for nitrogenous matter and ash in wheat and oats at different stages of growth (April 18 to August 6) during 5 years (1876, '77, '78, '81, '90) show that the amounts of these ingredients are very high at the outset (ash, highest found, 12.75 per cent; nitrogenous matter, highest found, 33.56 per cent) and constantly diminish as maturity advances. Determinations of tannin substances and gums in oats at different stages are also tabulated, showing a similar decline with the advance of maturity.

When the growth of the roots has reached a certain point the stem and leaves develop and the action of chlorophyll commences, carbonic acid gas is decomposed, and the carbon is fixed in the form of carbohydrates. These carbohydrates are believed to be in every case polymers, more or less advanced, of formic aldehyde. This polymerization accounts for all the carbohydrates in cereals—glucose, saccharoses, dextrine, starch, and cellulose—as well as for the two recently described materials, the vasculose of Dehérain and straw gum (*gomme de paille*) isolated by the author.* The percentages and yields per hectare of cellulose and straw gum in wheat and oats at different periods of growth (May 13 to August 6) are tabulated for three seasons (oats 1877, wheat 1881 and 1890). The proportion of these substances increases rapidly at first and then more gradually to the end of the life of the plant. The increase in the case of straw gum was from 3 to 20.21 per cent in oats and from 8.32 to 31.89 per cent in one instance in wheat. From these data the author states the order of development in the early life of cereals as follows: (1) Assimilation of nitrogenous and mineral matter; (2) chlorophyll action which produces those bodies which are changed by a very active respiration into gums, tannin, and vegetable acids; and (3) the assimilation of the carbon in the carbonic acid of the air, resulting in the production of the higher carbohydrates—cellulose, straw gum, and perhaps vasculose.

The processes of the maturing period now commence when the root is sufficiently developed and firmly fixed in the soil. The carbohydrates elaborated by the foliage are gradually converted into starch, the proportion of which steadily increases as maturity advances. It is shown, however, that this metamorphosis does not extend to the cellulose and straw gum except at the beginning of this period. The physiological changes which now go on in the plant are very susceptible to unfavorable influences of temperature, moisture, etc. The final product of the vital activity of the plant is starch, the proportion of which largely determines the quality of the crop, and is itself determined by the climatic conditions. This may be seen by comparing analyses of wheat grains grown in 1889, when the season was very dry, with the analyses of that grown in 1888, when the weather conditions were normal.

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* Etude de la paille; Ann. Agron., 16, p. 358; Compt. rend., 110, p. 97.

	Wheat (Scholey).		Wheat (Dattel).
	1888.	1889.	1889.
Protein	12.63	15.3	15.87
Starch	77.20	61.9	65.60

The proportions of protein and starch in the wheat of 1888 were normal, while it is evident that the conditions were such in 1889 that the elaboration of starch was seriously interfered with. The spring was very wet, insuring an abundant supply of nitrates for the formation of protein, while the summer was very dry, retarding the elaboration of the carbohydrates which were to form the starch.

The percentages and yield per hectare are tabulated of protein, reducing sugars, dextrin, straw gum, and starch in the different organs of the wheat plants grown in duplicate on 10 plats in 1891 and analyzed June 16, July 3, and August 3 and 19. The tables show that at the last date, which was slightly beyond maturity, there was a falling off in the proportion of certain constituents of the grain, particularly of starch, and demonstrate the importance of giving more attention to the choice of time of harvesting. The proportion of straw gum increased in all parts of the plant. Analysis of the grain with reference to gluten and starch showed similar results to those obtained in 1889. The proportion of gluten is normal, while starch is relatively low. Comparing the results with the 3 varieties for the 4 years we have the following:

	Scholey, 1888.	Dattel, 1889.	Scholey, 1889.	Golden Drop, 1891.
Ratio of gluten to starch	1: 6.13	1: 4.12	1: 4.04	1: 5.07

The season of 1891, like that of 1889, was unfavorable and produced similar results.

There seems, therefore, to be two periods in the development of wheat. During the first, extending up to the time of formation of grain, the roots assimilate nitrogenous and mineral matter, and in the other organs the carbon compounds elaborated by the leaves are used almost exclusively in building up the skeleton of the plant. This first period is generally passed under favorable conditions which explains why the plant more frequently contains its normal amount of nitrogenous matter. During the second period the sugars elaborated by the chlorophyll action are transformed into starch, which accumulates in the grain. This second period, in which the vital processes of the plant are very susceptible to unfavorable conditions of temperature or moisture, falls in a part of the season which is likely to present such conditions. As a result the grain matures too rapidly and is deficient in starch.

Contribution to the study of fermentations of manure, T. Schlösing, sr. and jr. (*Ann. Agron., 18 (1892), pp. 5–18*).—In manure piled in heaps two kinds of reaction take place. In the part where air circulates freely a lively combustion goes on, due to the action of aërobic microbes; carbonic acid is evolved in large quantities; and the temperature is raised considerably. In the part where free access of air is impossible, anaërobic microbes are active, setting free marsh gas, hydrogen, and carbonic acid, but producing much less heat. This subject has already been investigated by Dehérain and Gayon. Recent work by the authors is reported in detail.

(1) *Combustion with access of air, microbic and purely chemical.*—When manure as well as other organic matter is piled in mass with access of air the temperature gradually rises. This elevation of temperature seems to be due at first to the action of microbes, but it increases until the microbes are destroyed, and it is sufficiently high to enable the purely chemical combustion to go on unassisted. The author undertook to determine the exact temperature at which microbic action ceases. The method pursued for this purpose was to maintain at a constant temperature two lots of manure, one sterile and the other inoculated, and to pass slowly through each a continuous current of air, which was measured. The combustion was measured by the amount of carbonic acid evolved in each case. Five hundred or 1,000 grams of the moist manure finely divided and carefully mixed was introduced into metal cylinders, fitted with covers which could be soldered on. The cylinders were provided with lead tubes for the entrance of the air and the exit of the gaseous products. For the lot which was to remain sterile the entrance tube was provided with a glass tube plugged with a germ filter 20 to 25 cm. long. All the lots were sterilized at the same time by being kept for an hour in an oven at 115° C.

In the first series of tests inoculation was accomplished by withdrawing the material from the cylinders for a few moments immediately after sterilization and adding a few centimeters of a water extract of non-sterilized manure. The amount of air introduced into the cylinders in a given time was accurately determined. This amount was varied at different times as the intensity of combustion demanded, the object being to keep a considerable excess of oxygen present, and to maintain a proportion (1 to 2 per cent or less) of carbonic acid gas which could be accurately determined. Rapid and exact determinations of the latter were made by an apparatus specially devised for the purpose. All results are calculated to grams per kilogram of dry manure. The figures for the sterilized lots represent the purely chemical combustion; those for the inoculated lots, the sum of this combustion and that due to the ferments. The first experiment was made with fresh cow manure, rich in excrement, and containing 80 per cent of water. The temperatures in the case of different lots were 30°, 40°, and 50° C., and the experiment lasted 35 days. Up to the eleventh day there was no marked difference between the two lots, for the combustion was very

lively and the liberal supply of oxygen at first masked the influence of the ferments, but after that time the combustion was from four to eight times greater in the inoculated than in the sterile lots. The purely chemical combustion increased appreciably with the temperature. On examining the material at the end of the experiment it was found that the inoculated lots were further advanced in decomposition than those kept sterile, as shown by the appearance and physical condition. Fifty grams of each lot was placed on a filter and treated with water until the filtrate showed no further coloration. The residue was dried and weighed. It was found that the fermented lots gave considerably less residue than those kept sterile.

The second experiment, lasting from 23 to 26 days, was made with horse manure containing 60 per cent of moisture. The temperatures were 52°, 58°, and 66° C. The results show that microbic combustion was still active at 66° C., on the second day furnishing seventeen times as much carbonic acid as the purely chemical. These rather remarkable results led to the institution of another experiment to determine whether the removal of the material from the cylinder for inoculation may not have so improved its physical condition as to facilitate the production of carbonic acid. For this purpose the tops of both cylinders were soldered on before they were placed in the sterilizing oven, and after cooling a few liters of air which had passed through a flask in which dry manure was shaken up, were rapidly drawn through the cylinder to be inoculated. The same volume of air filtered through cotton was drawn through the cylinder which was to remain sterile, in order that the two might be strictly comparable. The inoculation by this means proved perfectly satisfactory. The experiment was made at a temperature of 65.5° C. with horse manure containing 73 per cent of moisture, and lasted for 5 days. The results confirmed those already obtained. In a fifth experiment, made with horse manure containing 71 per cent of moisture and lasting for 5 days, the temperature was maintained at 79.5° C. There was very little difference between the sterile and inoculated lots, showing that the microbes were not able to act at this temperature, but when the temperature was allowed to fall to 73° and the cylinder reinoculated, microbic action set in again vigorously. In order to verify these results and fix the temperatures between which microbic action ceases, similar experiments were made at temperatures of 72.5° and 81° C. The results confirmed the preceding.

The experiments, therefore, show that at 73° C. the aërobic microbes were still active, but that at 79.5° C. activity had ceased. Instances of ferments being active at such elevated temperatures are not frequent. The following have been observed: A micrococcus and a bacillus, cultivated by Van Tieghem at 74°,* and the *Bacillus thermophillus* of Miquel, cultivated at 70° to 71°†. Globig has also studied microörganisms

* Bul. Soc. Botanique, 28.

† Ann. de Micrographie, No. 1.

living at similar temperatures. Analysis of the gaseous products obtained in these experiments showed no combustible gas (CH_4 and H).

(2) *Anaërobic fermentation.*—In this series of experiments the method of procedure was the same as in those described above, except that a current of nitrogen was substituted for air. The gaseous products were analyzed eudiometrically. Horse manure containing 60 per cent of moisture was used. Temperatures of 52° and 66° C. were maintained, and the experiment lasted 17 days. At 52° marsh gas was evolved by the inoculated lot, but this evolution ceased at 66°. At 52° the production of carbonic acid and consequently the decomposition of the organic matter were much greater in the presence of microbes than in their absence, while in their absence decomposition was much greater at 66° than at 52°. In no case did the evolution of carbonic acid equal that in the aërobic fermentation.

Other experiments were made to determine whether gaseous nitrogen is set free when manure ferments without access of air. One hundred grams of finely divided manure was put into a 200-c. c. flask, which was immersed in a water bath at 45° C. The flask was connected with an apparatus for measuring the gas evolved. In 2 months there was obtained 850 c. c. of gas containing carbonic acid 713.6 c. c., hydrogen 38.8 c. c., and marsh gas 97.6 c. c. No nitrogen was present. In a similar experiment at 76.5° C. the evolution of gas was very lively. The manure did not change in color or odor, but simply became more friable. No nitrogen was found in this case. Hydrogen was generated in considerable quantity at the beginning of the experiment, but afterwards this ceased, and only carbonic acid and marsh gas were produced. In 2 months the following results were obtained:

	c. c.	*gr.*	C.	O.	H.
			gr.	*gr.*	*gr.*
CO_2 .... containing.	4,217.5	8.296	2.263	6.033	....
CH_4 ... containing.	4,577.4	3.276	2.457	....	0.819
	8,794.9	11.572	4.720		

Analysis of the manure before and after fermentation gave the following results:

	C.	H.	O.	N.	Mineral matter.
	gr.	*gr.*	*gr.*	*gr.*	*gr.*
Before fermentation	12.67	1.653	10.70	0.453	3.69
After fermentation	7.92	1.125	7.08	0.392	3.79
	—4.75	—0.528	—3.70	—0.061	+0.10

The amount of carbon lost (4.75 grams) agrees with that found in the gasometer (4.72 grams); this is equal to 37.5 per cent of the carbon in the original material.

It was observed that the nitrogen combinations decreased during fermentation. At the beginning there was 108.1 mg. of ammoniacal nitrogen, at the end 159.8 mg., an excess of 51 mg. If we add to this the milligrams corresponding to the 8.79 liters of ammonia gas evolved, we have practically the 61 mg. of loss shown by analysis. The loss of organic nitrogen is therefore practically equal to the gain in ammoniacal nitrogen; or in other words, the nitrogen given up by the organic matter is converted into ammonia.

The figures also show that during the fermentation the manure lost less oxygen and hydrogen than was found in the evolved gas. This excess of oxygen and hydrogen must have been supplied by the moisture present, as has been maintained by Liebig to be the case under such circumstances.

Summary.—In marsh-gas fermentation at 52° C. no gaseous nitrogen is produced. No nitrogen compounds are formed by the fixation of ammonia by the organic matter; on the contrary, nitrogen is given off in the form of ammonia. Water assists in the decomposition of organic matter, furnishing to the carbon a certain amount of oxygen and hydrogen.

Effect on the total yield of potatoes of removing the tubers from time to time, E. Wollny (*Forsch. auf. d. Geb. d. agr. Physik, 14, pp. 425–440*).—In the vicinity of European cities, where there is a demand for early potatoes, farmers follow the practice of digging into the hills before the tubers are all ripe and removing such as are large enough for cooking. The soil is then replaced and the others allowed to grow. This may be repeated two or three times during the development of the plant. Since it has been claimed that by this means the yield is increased, the effect of this practice on the total yield of potatoes was made the subject of investigation. In 1888, 1889, 1890, and 1891 a large number of different varieties of potatoes, including both early and late, were grown for the test. The large tubers were removed from some of the plants of each variety once before the final harvest, from others twice and three times, and on still others they remained undisturbed until all were dug. In every case from twenty to thirty plants received the same treatment. The conclusions from the results are that the total yield of tubers where they were removed once or more during the growing season was larger in number but less in weight than where the plants remained undisturbed until ripe. In general the disadvantageous influence of fractional harvesting on the weight of the total yield was more noticeable the earlier and the oftener the tubers were removed.

Stachys tuberifera.—This new vegetable, according to a description of it given by Dr. L. Just (*Deut. landw. Presse, 1891, p. 282*) is of Japanese origin and belongs to the *Labiatæ*. The elongated small white tubers, the part used for food, grow on the ends of stoloniferous

stems. In trials at the station in Carlsruhe, Baden, the tubers were planted in rows the last of March, and ripened the last of November. The yield ranged from 3,200 to 3,500 pounds of tubers per acre. The tubers were left in the ground and removed during moderate weather as wanted. They were not injured by frost. In taste the tubers are said to resemble potatoes, asparagus, or chestnuts, according to the way they are prepared. They are most commonly cooked and eaten like potatoes. Early in March the tubers commenced to sprout, so that it was necessary to harvest them. Both on account of the low yield as compared with potatoes, and their peculiar taste, stachys can not be expected to find such universal and common use as the potato, but it is regarded as a vegetable of much promise.

The composition of the tubers is given by Strohmer and Stift (*Oester-ungar. Zeitsch. f. Zucker-Ind. u. Landw.*, 20, p. 803; abs. in *Chem. Centralbl.*, 1892, part I, p. 398) as follows:

Composition of tubers of Stachys tuberifera.

	In fresh tubers.	In dry matter.
	Per cent.	*Per cent.*
Water	78.05	....
Crude ash	1.20	5.58
Crude cellulose	0.73	3.33
Crude fat	0.16	0.73
Albuminoids	1.17	5.34
Non-albuminoid protein	3.14	14.33
Stachyose	13.92	63.50
Nitrogen-free extract	1.60	7.29

Of 100 parts of nitrogen in the tubers there were present in the form of—

	Per cent.		Per cent.
Albuminoids	19.01	Amido acid amides	42.96
Nuclein	8.13	Amido acid	16.26
Ammonia	7.84	Undetermined	5.80

The nutritive value of stachyose is said to be practically the same as that of other carbohydrates, but it is easily soluble in water and is therefore more easily digested than the insoluble starch of potatoes. The tubers also contain more protein compounds than potatoes.

Feeding grade steers of different breeds, T. Shaw and C. A. Zavitz (*Ontario Agr. College Expt. Station Bul. No. 70, December 1, 1891, pp. 10*).—The objects of this experiment were (1) to determine the average cost of raising grade steers for beef "when fed on a heavy or forcing ration"; (2) to compare the effect of whole milk *vs.* skim milk on the cost while they were fed and on future development; and (3) to compare the cost of producing beef from grade and from native animals. Eight animals were used, one native and one each of the following grades: Galloway, Aberdeen Polled, Hereford, Devon, Holstein, and two grade Shorthorns. At the commencement of the trial the Galloway

was 53 days old, one Shorthorn was 14 days old, the others were all less than 9 days old. The animals are to be fed unti 12 years old. The report is here given for the first 12 months of feeding.

During the first 6 months the animals were kept in box stalls and were fed milk, grain (ground peas, oats, wheat screenings, and bran), cut hay, and green fodder in season (oats and peas, clover and millet). The grain was fed dry with the hay. The aim was to give each animal about the same amount of grain, but this was not strictly adhered to. Whole milk was given in every case, except that of one Shorthorn, which received skim milk.

During the second 6 months the animals were tied in stalls and allowed about an hour's exercise daily. They were fed cut hay, green fodder, sliced turnips, and mangel-wurzels, and grain consisting during the first 3 months of four parts by weight each of ground peas, ground oats, wheat screenings, and bran, and three parts of oil cake, and during the last three months of two parts each of ground peas and oats and one part of bran. The estimates of the cost of the food are based on the following prices:

Hay	per ton..	$5.00	Peas	per bushel..	$0.47
Green fodder	do....	2.00	Wheat screenings	do....	0.30
Bran	do....	12.80	Roots	do....	0.08
Oil cake	do....	26.66	Whole milk	per 100 pounds..	0.60
Oats	per bushel..	0.25	Skim milk	do....	0.15

At the end of the first year the grade animals were valued by experts at prices varying from 4.75 to 5.5 cents per pound live weight for the different animals, and the native at 3.75 cents. The financial statement at the close of the first year stood as follows:

Financial results of 1 year's feeding.

Grades.	Cost of— Animal at birth.	Cost of— Food.	Cost of— Attendance.	Total cost.	Value of— Animal.	Value of— Manure.	Total value.	Gain (+) or Loss (—).
Galloway	$2.00	$27.22	$5.63	$34.85	$44.00	$6.00	$50.00	+ $15.15
Shorthorn (fed whole milk)	2.00	47.53	5.63	55.16	48.95	6.00	54.95	— 0.21
Aberdeen Poll	2.00	43.02	5.83	50.65	39.59	6.00	45.59	— 5.06
Hereford	2.00	46.47	5.63	54.10	49.50	6.00	55.50	+ 1.40
Devon	2.00	41.62	5.63	49.25	44.17	6.00	50.17	+ 0.92
Holstein	2.00	48.53	5.63	56.16	41.94	6.00	47.94	— 8.22
Average (grades of six breeds)	2.00	42.40	5.63	50.03	44.69	6.00	50.69	+ 0.66
Shorthorn (fed skim milk)	2.00	29.59	5.63	37.22	40.28	6.00	46.28	+ 9.06
Scrub or native	1.00	39.61	5.63	46.24	27.13	6.00	33.13	— 13.11

It will be observed that [at the prices charged] the animal fed on skim milk cost $12.81 less than the average grade fed on whole milk, and $9.02 less than the native or scrub, whereas he gave a net gain of $9.72 in advance of the former and of $22.17 in advance of the latter. While the native or scrub cost $3.79 less than the average grade, the net return given by him was also $17.56 less; that is to say, he cost $13.77 more than the former when 1 year old. He not only made the lowest gain per day, but was also rated the lowest by the valuators.

Experiments with spring grain, T. Shaw and C. A. Zavitz (*Ontario Agr. College Expt. Station, Bul. No. 71, February 22, 1892, pp. 8*).—Notes and tabulated data are given for 10 varieties of oats, 10 of wheat, and 13 of barley, which have been tested at the station for 3 years (1889–91). There are also notes on other varieties which have been less thoroughly tested. The varieties giving the highest yields in bushels per acre were as follows: *Oats.*—Joanette Black 85, Chenailles Black 81, Black Etampes 80, Houdan Black 79, Siberian 78. *Wheat.*—Herison Bearded 26, Pringle Champion 23, Summer 22, Holben Improved 22, Odessa Ghirka 21. *Barley.*—Manshury 59, Chevalier 55, Empress 54, Hallett Pedigree 53, Oderbrucker 52, Scotch Improved 52. Of the foreign varieties of wheat tested, Pringle Champion has been placed first for milling purposes. An account is given of an experiment in which barley, wheat, and oats were sown at six different dates, from April 22 to June 6, inclusive. Barley and oats sown May 1 and 9 gave the largest yields, but the earliest sowing of wheat was most productive.

Roots, potatoes, and fodder corn, T. Shaw and C. A. Zavitz (*Ontario Agr. College Expt. Station Bul. No. 72, February 29, 1892, pp. 8*).—Notes and tabulated data on tests of varieties of Swede turnips, turnips, mangel-wurzels, sugar beets, potatoes, and corn for fodder. The varieties which gave the best yields in 1890 and 1891 were as follows: *Swede turnips* (tons per acre).—Royal Norfolk Purple Top 21, Hazard Swede 21, Carter Elephant 20. *Turnips* (tons per acre).—Red Globe Norfolk 27, Red Top Strap Leaf 23, Pomeranian White Globe 22, all varieties with white flesh. *Mangel-wurzels* (tons per acre).—Norbitan Giant 23, Long Red 19, Carter Warden Orange 18. *Potatoes* (bushels per acre).—Empire State 193, Summit 147, Early Maine 141, Clark No. 1 138. *Corn for fodder* (tons per acre).—Sheep Tooth 16, Chester County Mammoth 16, Calico Dent 15, Leaming Dent 15, Cranberry White Dent 15, Compton Early 15, Wisconsin Yellow Dent 15, Mammoth Southern Sweet 15, Southwestern 14, Wisconsin White Flint 14.

"While the average yield of the 11 varieties of white-fleshed turnips per acre was 853 bushels, that of the 4 yellow-fleshed varieties was but 673.3 bushels.

"While the average yield of the 14 distinctively long varieties of mangel-wurzels was 952 bushels per acre, that of the 6 globe varieties was but 747 bushels. * * *

"For quantity and quality of fodder and earliness in maturing, Compton Early, Wisconsin White Flint, Leaming Yellow, and Wisconsin Yellow Dent are probably the most suitable for the silo among the 35 varieties tested here for the past 3 years.

"In a test [of level and ridge culture] the mangel-wurzels grown on the level gave a considerably larger yield than when grown on ridges, while the difference with the turnips and sugar beets was but slight."

Effect on the chemical composition of milk ash of feeding precipitated phosphate of lime, E. Hess and Schaffer (*Landw. Jahrb., d. Schweiz., 1891, p. 76; abs. in Chem. Ztg., rep. p. 15, and Chem. Centralbl., 1892, part 1, p. 570*).—Precipitated basic phosphate of lime, containing 38.45 per cent of phosphoric acid and 34.12 per cent of calcium oxide was added to meadow grass, bran, and ground rye, the ration of cows whose milk ash contained normally about 26 per cent of phosphoric acid. Fifty grams of the phosphate were fed per head per day. The phosphoric acid in the milk ash increased 3 to 4 per cent during this feeding, and in one case reached 31.8 per cent. (It is not stated whether there was likewise an increase in the percentage of milk ash.) By feeding the phosphate to cows affected with a disease of the udder known in Switzerland as *Galt*, in which the milk secreted contains an abnormally low percentage of phosphates, it was found possible to gradually bring the percentage of phosphoric acid in the milk ash up to the normal, although no cure of the disease had been effected in the meantime.

Effect on the constitution of the milk fat of adding sugar to the food, A. Mayer (*Milch Ztg., 1892, pp. 49, 50*).—This trial was made with one cow. The basal ration fed consisted of 70 pounds of diffusion residue, 11 pounds of rye straw, and 88 pounds of linseed cake per day. This was fed in the first period (November 17 to 26); 4.4 pounds of cane sugar per day was added in the second period (November 26 to December 6); and the basal ration was fed again in the third period (December 7 to 17). The character of the butter produced in each period is shown in the following table:

Butter produced with and without sugar.

		Melting point.	Solidifying point.	Volatile fatty acids.
		Degrees C.	*Degrees C.*	*c. c.*
Period 1, basal ration	Nov. 24.	41.7	24.7	24.2
	Nov. 26.	42.4	25.4	25.0
Period 2, basal ration and sugar	Dec. 4.	39.1	20.9	26.9
	Dec. 6.	39.0	21.7	29.2
Period 3, basal ration	Dec. 15	40.8	22.6	27.9
	Dec. 17	41.1	22.9	28.1

The melting point and point of solidification were both lowest during the second period, when sugar was fed. The volatile fatty acids also increased during this period. It is believed the effects of the sugar would have been more plainly visible had the periods been separated by transition periods.

The reaction of cows' milk and human milk, and its relation to the reaction of casein and the phosphates, G. Courant (*Arch. f. d. ges. Physiol., 50, pp. 109–165; abs. in Ber. d. chem. Ges., 24, ref. p. 975*).—Both human milk and cows' milk show an alkaline reaction with lacmoid and an acid reaction with phenol phthalein, but both the acidity

and the alkalinity of cows' milk are the greater. Casein forms three compounds with calcium or sodium, the mono, di, and tricalcic (or sodic) casein. These are all alkaline to lacmoid and neutral to phenol phthalein, and are decomposed by water. If to a solution of casein in lime-water sufficient hydrochloric or sulphuric acid be added to combine with all the lime present, the casein will be completely precipitated. If phosphoric acid be used instead the precipitation of the casein occurs first when all the lime has been changed to monocalcic phosphate. Only the dicalcium or disodium casein compounds are curdled by rennet in the presence of water-soluble lime salts, and the completeness of the curdling depends on the amount of lime salts present. The reaction of these casein solutions before the rennet is added is like that of milk, alkaline to lacmoid and acid to phenol phthalein. The acidity of the two is about the same, but the milk is stronger in its alkaline reaction owing to larger amounts of insoluble phosphates, and especially to the soluble dialkali phosphate it contains. The less complete curdling of human milk, as compared with cows' milk, is due to the increased alkalinity of the latter. The decrease of milk in acidity when diluted with water is a result of the decomposition of the lime-casein compounds and the phosphates; the diminution of alkalinity is caused only by the presence of lime-casein compounds. By cooking, the alkalinity and the acidity of milk are both reduced. The addition of calcium chloride to milk causes no change in its alkalinity but increases its acidity. The change in the casein caused by adding rennet to milk has no connection with the reaction. In curdling with rennet the dicalcium-casein compound is precipitated.

Linseed cake vs. sesame cake for milch cows (*Wekelijsche Landbouw Kroniek, 1892; abs. Braunschwg. landw. Ztg., 1892, p. 31*).—In Holland linseed cake was formerly almost universally accredited the first place among concentrated feeding stuffs for milch cows. More recently sesame cake has competed strongly with it, and the past year the Dutch Agricultural Society (*Hollandsche Maatschappy van Landbouw*) appointed a commission to test the relative merits of the two feeds in comparative experiments with milch cows. These experiments were made on four different farms, four cows being used in each case. These were divided into two lots, containing animals as nearly alike as possible, one lot receiving linseed cake and the other sesame cake in the first period (March 5 to 26), and both lots being reversed in the second period (March 26 to April 25). The cows all received the same amount of the basal ration, and like money values of the cakes were fed. The linseed cake cost $4.33 per 100 cakes and the sesame cake $4 per 100.

The composition of the two cakes was as follows:

	Linseed cake.	Sesame cake.
	Per cent.	*Per cent.*
Water	13.38	11.04
Crude ash	5.30	12.57
Crude cellulose	7.23	6.87
Crude fat	13.70	15.34
Albuminoids	33.42	37.45
Starch	26.81	16.72

The results of one experiment were discarded on account of the death of one of the cows. In general the results at the three other farms showed an increased milk yield with sesame cake, but a lower yield of total fat in the milk than with linseed cake. The relation between the milk yield on the two feeds is given for the several experiments as follows:

	On sesame cake.	On linseed cake.
	Liters.	*Liters.*
1	1,000	986
2	1,000	971
3	1,000	975

The relative amounts of fat in the milk were:

	On linseed cake.	On sesame cake.
	Pounds.	*Pounds.*
1	100	73.5
2	100	86.8
3	100	92.3

The milk produced on linseed cake was therefore relatively the richer in fat.

The relative amounts of solids not fat in the milk were:

	On linseed cake.	On sesame cake.
	Pounds.	*Pounds.*
1	100	100.0
2	100	103.8
3	100	102.0

Estimates of the money value of the ingredients of the milk produced on the two feeds, calculating one part of fat as equal to three and to four parts of solids-not-fat, respectively, indicated the milk constituents produced on linseed cake to be of slightly higher value than those produced on sesame cake. As like money values of the two cakes were fed, the financial advantage would seem in these cases to be on the side of linseed cake, and a milk relatively richer in fat was also produced with this cake.

Steamed vs. cracked corn for fattening pigs, D. A. De Jong Tyn (*abs. from the Dutch in Milch Ztg., 1892, p. 21*).—Two lots of four pigs, about 3 months old, were fed from March 28 to July 27, the one steamed and the other cracked corn, in addition to whey, of which both lots received the same quantity. The lot receiving steamed corn consumed 46.8 bushels of corn and gained 664.4 pounds live weight, or 14.2 pounds per bushel of corn; while the lot receiving cracked corn consumed 49.7 bushels of corn and gained 781 pounds live weight, or 15.7 pounds per bushel of corn. The advantage was therefore with the lot receiving the cracked corn.

TITLES OF ARTICLES IN RECENT FOREIGN PUBLICATIONS.

On the chemical constitution of albuminoid bodies (*Ueber die chemische Konstitution der Eiweisskörper*), H. Arnaud.—*Centralbl. f. Bakt. u. Par., 11, p. 11.*

Preparation and characteristics of transparent congealed blood serum and egg albumen (*Das durchsichtig erstarrte Blutserum und Hühnereiweiss*), E. Zoth.—*Centralbl. f. Physiol., 5, pp. 742, 743.*

Contributions to the chemistry of cellulose, C. F. Cross and E. J. Bevan.—*Chem. News, 65, pp. 77, 78.*

Determination of starch in potatoes (*Bestimmung von Stärke in den Kartoffeln*), A. Baudry.—*Zeitsch. f. Spiritusindustrie, 15, pp. 41, 42.*

Contributions to the knowledge of carbohydrates (*Zur Kenntniss der Kohlehydrate*), F. Ullik.—*Zeitsch. f. das ges. Brauwesen, 15, pp. 15–17, 28–31, and 39–41; abs. in Chem. Centralbl., 1892, I, p. 432.*

The pentaglucoses, their occurence in plants and their determination (*Ueber die Pentaglykosen, ihr Vorkommen in Pflanzenstoffen und ihre analytische Bestimmung*), B. Tollens, A. Günther, and De Chalmot.—*Jour. f. Landw., 40, Heft 1, pp. 11-18.*

Contributions to the knowledge of nuclein (*Beiträge zur Kenntniss der Nucleine*), H. Malfatti.—*Zeitsch. f. physiol. Chem., 16, Hefte 1 and 2, pp. 68–86.*

On adenin (*Zur Kenntniss des Adenins*), M. Krüger.—*Zeitsch. f. physiol. Chem., 16, Hefte 1 and 2, pp. 160–172; Hefte 4 and 5, pp. 329–340.*

On adenin and hypoxanthin (*Ueber Adenin und Hypoxanthin*), G. Bruhns and A. Kossel.—*Zeitsch. f. physiol. Chem., 16, Hefte 1 and 2, pp. 12.*

Contributions to the analysis of fats, J. Lewkowstche.—*Jour. Soc. Chem. Ind., 11, pp. 134–145.*

Studies on the determination of crude fiber (*Zur Kenntniss der Rohfasserbestimmung*), S. Gabriel.—*Zeitsch. f. physiol. Chem., 16, Hefte 4 and 5, pp. 370–386.*

On the examination of animal feeding stuffs; a chemical characteristic of putrefaction (*Beiträge zur Untersuchung animalischer Nahrungsmittel. II. Ein chemisches Merkmal der Faulnis*), W. Eber.—*Arch. f. Tierheilkunde, 18, pp. 110–117.*

Estimation of free and albuminoid ammonia in water, W. F. Lowe.—*Jour. Soc. Chem. Ind., 11, p. 133.*

Preparation and keeping of germ-free distilled water (*Darstellung und Aufbewahrung keimfreien destillirten Wassers*), A. Gawalowski.—*Pharmazeut. Post, 25, pp. 155, 156.*

The quantitative determination of minute quantities of lime (*Ueber die quantitative Bestimmung geringer Mengen von Kalk*), M. Krüger.—*Zeitsch. f. physiol. Chem., 16, Hefte 4 and 5, pp. 445–452.*

On the employment of color reactions for testing precipitates of albuminoids with potassium ferrocyanide (*Ueber die Verwendbarkeit von Farbenreactionen zur Prüfung von Ferrocyankalium-Eiweissniederschlägen*), H. Winternitz.—*Zeitsch. f. physiol. Chem., 16, Hefte 4 and 5, pp. 439–444.*

Behavior of ferrous iodide toward starch and filter paper (*Ueber das Verhalten von Eisenjodür zu Stärke und Filtrirpapier*), T. Salze.—*Chem. Ztg., 1892, 26, p. 421.*

Further experience with alkali-glycerol as the saponifying agent in the Reichert process, F. LEFFMANN and W. BEAM.—*Analyst, 1892, April, pp. 65, 66* (earlier paper in *Analyst* for August, 1891).

Purification of lacmoid, M. C. TRAUB.—*Schweiz. Wochensch. f. Pharm., 30, p. 53.*

On the chemistry of the vegetable cell membrane, second paper (*Zur Chemie der pflanzlichen Zellmembranen, zweite Abhandlung*), E. SCHULZE.—*Zeitsch. f. physiol. Chem., 16, Hefte 4 and 5, pp. 387–438.*

Alkaloids of the white lupine, A. SOLDAINI.—*Rendiconti della Acad. dei Lincei* (*Roma*), *7, pp. 469-471.*

Mannit and sorbit in the fruit of the cherry laurel (*Sur la présence de la mannite et de la sorbite dans les fruits du laurier-cerise*), C. VINCENT and DELACHANAL.—*Compt. rend., 114, pp. 486, 487.*

Root tubercles on leguminous plants, 1858 (*Ueber Knollen an den Wurzeln der Leguminosen*), J. LACHMANN.—*Landw. Mitt., Zeitsch. der K. höheren Landw. Lehranstalt, etc., zu Poppelsdorf, 1858, Heft 1;* reprinted in *Centralbl. f. agr. Chem., 20, Heft 12, pp. 837–854.*

Investigations on the variations in the transpiration of flowers during their development (*Recherches sur les variations de la transpiration de la fleur pendant son développement*), G. CURTEL.—*Compt. rend., 114* (*1892*), *pp. 847–849.*

On the origin of the coloring matter of grapes; on the grape-coloring acids and the autumnal coloring of plants (*Sur l'origine des matières colorantes de la vigne; sur les acides ampélochroïques et la coloration automnale des végétaux*), A. GAUTIER.—*Compt. rend., 114 (1892), pp. 623–629.*

Trial of a theory regarding the production of galls on plants (*Essai d'une théorie sur la production des diverses galles végétales*), A. LABOULBENE.—*Compt. rend., 114* (*1892*), *pp. 720–723.*

The control of the potato rot (*Die Bekämpfung der Kartoffelkrankheit, Peronospora infestans*), STEGLICH and ANDRÄ.—*Sächs. landw. Zeitsch., 1892, No. 10, pp. 91–96; No. 11, pp. 103–108; and No. 13, pp. 125–130.*

The reactions of unorganized ferments (*Die Reactionen der ungeformten Fermente*), G. TAMMANN.—*Zeitsch. f. physiol. Chem., 16, Hefte 4 and 5, pp. 271–328.*

Investigations of soluble ferments (*Untersuchungen über lösliche Fermente*), J. JACOBSON.—*Zeitsch. f. physiol. Chem., Hefte 4 and 5, pp. 340–370.*

Further investigations on the tryptic enzymes of microörganisms (*Weitere Untersuchungen über die tryptische Enzyme der Mikroorganismen*), C. FERMI.—*Arch., f. Hygiene, 14, Heft 1, pp. 44.*

An aërobic ferment in straw which reduces the nitrates (*De la présence dans la paille d'un ferment aérobic, réducteur des nitrates*), E. BREAL.—*Compt. rend., 114* (*1892*), *pp. 681–684.*

Recognition, occurrence, and importance of the diastatic enzymes of plants (*Nachweis, Vorkommen, und Bedeutung des diastatischen Enzyms in den Pflanzen*), J. WORTMANN.—*Bot. Ztg., 1891, Nos. 37–41.*

Cradine, a new peptic ferment (*Cradine, ein neues peptisches Ferment*), MUSSI.—*Vierteljahrsch. ü. d. Fortschr. a. d. Geb. d. Chem. d. Nahrungsmittel, 6, p. 293.*

The fermentation of blood (*Sur la fermentation du sang*), BERTHELOT and ANDRÉ.—*Compt. rend., 114 (1892), pp. 514–520.*

The chemical relations of bacterial life (*Die chemischen Verhältnisse des Bakterienlebens*), O. LÖW.—*Centralbl. f. Bakt. u. Par., 9, Heft 20.*

Butyric acid and Bacillus subtilis (*Ueber Buttersäure und den Bacillus subtilis*), B. LEDERER.—*Chem. Ztg., 1892, p. 252.*

On a Bacillus butyricus found in milk (*Ueber einen Bacillus butyricus*), S. BOTKIN.—*Zeitsch. f. Hygiene, 11, pp. 421–434.*

Investigations on the determination of the manurial requirements of soils by means of plant analysis (*Untersuchungen über die Feststellung des Düngerbedürfnisses der Ackerböden durch die Pflanzenanalyse*), A. H. HELMKAMPF.— *Jour. f. Landw., 40, Heft 1, pp. 85–112.*

A new method for ascertaining the manurial needs of soils (*Ueber eine neue Methode der Bestimmung des Düngerbedürfniss unserer Ackerböden*), A. HELMKAMPF.—*Centralbl. f. agr. Chem., 20, Heft 12, pp. 826–828.*

The comparative effect of sulphate of iron and sulphate of lime on the conservation of the nitrogen in bare soils, and on nitrification (*Influences comparées du sulfate de fer et du sulfate de chaux sur la conservation de l'azote dans les terres nues et sur la nitrification*), P. PICHARD.—*Ann. de Chim. et de Phys., tom. 25, sér. 6, Feb., 1892, pp. 271–287.*

The best time and manner of applying potash salts (*Die beste Zeit und Art der Anwendung der Kalisalze*), M. MAERCKER.—*Fühling's landw. Ztg., 1892, Apr. 15, pp. 290-293.*

The value of potash manuring for increasing and cheapening agricultural production (*Die Kalidüngung in ihrem Werthe für die Erhöhung und Verbilligung der landwirthschaftlichen Produktion*), M. MAERCKER.—*Berlin, 1892, p. 287.*

The application of potash salts in the culture of sugar beets on clayey soils containing nematodes (*Die Anwendung der Kalisalze für den Anbau der Zuckerrüben in dem (nematodenfuhrenden) Lehmboden*), M. MAERCKER.—*Deut. landw. Presse, 1892, pp. 245, 246.*

Returns for manuring sugar beets with phosphoric acid (*Rentabilität und Düngung mit Phosphorsäure zu Rüben*), WEGENER.—*Deut. landw. Presse, 1892, No. 31, p. 344.*

Suggestions for field experiments with fertilizers for field beets (*Vorschläge zu Felddüngungsversuchen mit Futterrüben*), PAUL WAGNER.—*Deut. landw. Presse, 1892, 29, p. 320.*

Influence of nitrogenous manures on the structure and the nitrogen content of barley (*Ueber den Einfluss der Stickstoffdüngung auf die Structur und den Stickstoffgehalt der Gerstenkörner*), C. KRAUS.—*Zeitsch. f. das ges. Brauwesen, 1892, 15, p. 105.*

Effect of copperas in the soil on the yield of grains (*Einfluss von Eisenvitriol im Boden auf den Ertrag der verschiedenen Getreidearten*), A. MAYER.—*Jour. f. Landw., 40, Heft 1, pp. 19–22.*

Coöperative field experiments with barley (*Gersten-Anbauversuche des Vereins "Versuchs- und Lehranstalt für Brauerei in Berlin," 1891*), C. VON ECKENBRECHER.—*Sächs. landw. Zeitsch., 1892, No. 14, pp. 138–140.*

On the growth of the vine (*Sur la végétation de la vigne*), L. ROOS and E. THOMAS.—*Compt. rend., 114 (1892), p. 593.*

The composition of cooked vegetables, K. J. WILLIAMS.—*Chem. News, 65, p. 46.*

Effect of food on the composition of the ash of the blood (*Ueber den Einfluss der Nahrung auf die Zusammensetzung der Blutasche*), K. LANDSTEINER.—*Zeitsch. f. physiol. Chem., 16, Hefte 1 and 2, pp. 13–20.*

The digestibility of the protein in normally dried and in partly burned brewers' grains (*Verdaulichkeit des Proteins in normal getrockneten und theilweise verbrannter Biertrebern*), B. SCHULZE.—*Abs. in Milch Ztg., 1892, No. 12, pp. 190, 191.*

Feeding experiments with disembittered lupine (*Fütterungsversuche mit entbitterten Lupinen*), S. GABRIEL.—*Jour. f. Landw., 40, Heft 1, pp. 23–46.*

Results of feeding brewers' grains to horses (*Erfahrungen mit der Verfütterung der Biertreber an Pferde*), E. POTT.—*Landw. Thierzucht, 1892, No. 7.*

On the composition of milk and milk products, P. VIETH.—*Analyst, 1892, April, pp. 62–65.*

The determination of fat in cream by Soxhlet's aërometric method (*Die Bestimmung des Fettgehaltes im Rahm nach der araometrischen Methode*), H. VON TÖRRING.—*Milch. Ztg., 1892, No. 12, p. 190.*

On the optical and chemical analysis of butter, F. JEAN.—*Monit. scient., 1892, 4, sér. 6, p. 91.*

Behavior of butter and margarine towards coloring matters (*Verhalten der Butter und Margarine gegen Farbstoffe*), M. WEILANDT.—*Milch Ztg., 1892, No. 15, pp. 238–241.*

What shall we do with centrifugal skim milk (*Was machen wir mit der Centrifugen-Magermilch*)? EISBEIN.—*Zeitsch. d. landw. Ver. in Bayern, 1892, pp. 8–17.*

The rancidity and the preservation of butter, C. BESANA.—*Le Stazione speriment. agric. ital., 21, pp. 456–465.*

The cause of abnormal ripening of cheese (*Ueber die Ursachen und die Erreger der abnormalen Reifungsvorgänge beim Käse*), L. ADAMETZ.—*Milch. Ztg., 1892, No. 13, pp. 205–208; No. 14, pp. 221–223.*

Determination of the acidity due to the fixed and volatile acids of wine (*Sur la determination de l'acidity due aux acides fixes et volatiles du vin*), J. A. MÜLLER.—*Ann. Chim. et phys., tom. 25, sér. 6, pp. 118–125.*

The specific gravity of silk (*Le poids spécifique de la soie*), L. VIGNON.—*Compt. rend., 114 (1892), pp. 603–605.*

Report of the Experiment Station at Bonn, Germany, 1891 (*Bericht über die Thätigkeit der Versuchs Station im Jahre 1891*).—*Zeitsch. d landw. Ver. f. Rheinpreussen, 1892, No. 10, pp. 73–75; No. 11, pp. 81–83.*

EXPERIMENT STATION NOTES.

ALABAMA COLLEGE STATION.—April 14 cotton was ginned at the station with the aid of an electric motor, the power being conveyed from the college over a wire more than half a mile long. This is believed to be the first application of electricity to the ginning of cotton.

FLORIDA STATION.—A. W. Bitting, B. S., has been added to the station staff as veterinarian, and J. K. Fitzgerald, B. S., has been appointed horticulturist. P. H. Rolfs, M. S., formerly assistant botanist of the Iowa Station, has been appointed botanist and entomologist vice J. C. Neal, M. D. Director J. P. DePass has just returned from Cuba, where he has been investigating tobacco culture and manufacture. The station has been making distribution of tobacco seed and fruit trees to applicants in the State.

ILLINOIS STATION.—*Science* for April 15, 1892, contains an account of observations on the growth and chemical composition of the maize plant by E. H. Farrington.

KENTUCKY STATION.—C. L. Curtis, assistant agriculturist, died April 4, 1892.

MINNESOTA STATION.—Andrew Boss has been appointed farm foreman and T. L. Haecker instructor in butter making.

NEW JERSEY STATIONS.—The First Annual Report of the New Jersey weather service for 1890 (pp. 576) has recently been received.

NEW MEXICO COLLEGE.—At a recent meeting of the board of regents new courses of study of a higher grade than those now given were submitted by President Hadley and approved by the board. It was decided to divide the departments of botany and chemistry and to have the professor of chemistry also act as chemist to the station.

OKLAHOMA STATION.—A. V. McDowell has been appointed superintendent of the farm. An orchard of more than 2,000 trees is being planted and 51 acres of land have been prepared for field experiments. The station barn has been completed and other buildings are well under way.

PENNSYLVANIA STATION.—The address of the station for express and freight is now State College, the same as its post office and telegraph address.

SOUTH DAKOTA STATION.—In accordance with the rules and regulations adopted by the State board of regents of education January 7, 1892, the station is put under the general management of a station council consisting of the president of the college, the professors of agriculture, entomology, chemistry, dairy science, botany, horticulture, and veterinary science, and such other officers as may from time to time be designated by the board of regents. "All allotments of money to the different departments of the station, all expenditures and purchases, all estimates of equipment, all important lines of work to be undertaken, and in short the entire policy of the experiment station are to be determined by vote of the council subject to the approval of the board of trustees; and all recommendations and reports to the board must be made through the regular channels of procedure of the station council."

UTAH STATION.—The board of trustees recently appointed includes the following members: W. S. McCornick, president, Salt Lake City; J. B. Keeler, Provo; R. W. Cross, Ogden; J. T. Hammond, Logan; A. A. Heyward, Ogden; G. Barber, Logan; W. R. Stover, Logan; A. M. Fleming, treasurer, and J. T. Cunie, jr., secretary. S. S. Twombly, B. S., D. V. S., has been added to the station staff as consulting chemist.

QUEENSLAND, DEPARTMENT OF AGRICULTURE, BRISBANE.—Bulletin No. 14, December, 1891 (pp. 12), contains an article on rice growing and its preparation for market.

Bulletin No. 15, January, 1892 (pp. 14), is on Tobacco, its Cultivation in Southern Queensland, by S. Lamb. Practical directions are given for the culture, curing, and packing of tobacco, with special reference to the conditions of agriculture in Queensland. In spite of the fact that tobacco is protected by a customs duty the imports of American tobacco are increasing. The author believes that Queensland growers should devote themselves to raising high-grade tobacco for home consumption and export, leaving to other countries the production of the low and medium grades.

Bulletin No. 16, January, 1892 (pp. 27, figs. 10), by E. M. Shelton, consists of excerpts from bulletins of the U. S. Department of Agriculture and of the American experiment stations, with notes and comments with reference to the needs of agriculture in Queensland. In a number of cases the abstracts are taken from the Experiment Station Record. The subjects treated are, The Establishment of Creameries (Texas Station Bulletin No. 5), Treatment of Scale Insects (U. S. Division of Entomology Bulletin No. 23), Waste of Manure in the Land (Kansas Station Report for 1888), Care of Farm Manure (New York Cornell Station Bulletin No. 27), Composition of the Ramie Plant (California Station Bulletin No. 94), Insecticides (New Jersey Stations' Bulletin No. 75), Clarifying Reagents used in Sugar Making (Louisiana Stations' Bulletin No. 11), Potato Trials (Utah Station Bulletin No. 5). Abstracts of these publications may be found in Experiment Station Record, vol. I, p. 151; vol. II, pp. 415 and 664; vol. III, pp. 89, 371, and 389; and Experiment Station, Bulletin No. 2, part II, p. 12.

GERMAN REGULATIONS FOR THE SALE OF FEEDING STUFFS.—At a congress of representatives of experiment stations, the trade, and farmers, held in Berlin February 20, 1892, the following general regulations were agreed upon to govern the trade in "artificial" feeding stuffs:

In every sale the seller is to furnish, without request, a written guaranty of the name, purity, composition, and condition of the feeding stuff, together with a statement as to the compensation which will be allowed in case the material falls below the guarantied composition, and the manner in which this shall be adjusted. It is recommended that in the retail trade the guaranty be affixed to each bag, together with the name of the dealer, weight of the parcel, and the name of the experiment station under whose control the dealer has placed himself.

The guaranty of composition shall in all cases show the percentages of protein and of fat separately, and not the sum of the two, as has been customary, and may also show the percentage of carbohydrates. These percentages represent the minimum content; the guaranties showing the extreme range of composition (as 18–20 per cent) are not allowable. The compensation for deficiency in guarantied nutrients may be adjusted in either of two ways, (1) on the basis of equivalents in which a deficiency of one ingredient is compensated for by an excess of another, or (2) according to the so-called Bernburg analysis latitude. In the former case limits are fixed to the extent to which one ingredient shall be allowed to compensate for another. Thus, where less than 10 per cent of fat is guarantied, not over 1 per cent is replaceable; above this guarantied amount, 2 per cent; and for 10 per cent of protein guarantied, not over 3 per cent is replaceable. According to the Bernburg analysis latitude, no compensation is to be exacted where the deficiency does not exceed 1.5 per cent for protein or 0.5 per cent for fat. Beyond these limits rebate is to be made for all the deficiencies. When the adjustment is according to the latter method the adjustment on the basis of equivalents can not be used, and *vice versa*. Where feeding stuffs are sold directly on the basis of the food ingredients they contain no latitude is allowable.

Upon proof that a feeding stuff is untrue to name, spoiled, unhealty, or mixed with less valuable stuff, the seller is to make good all expenses or losses of the buyer.

The determination of the composition is to be left to the experiment station agreed upon between seller and buyer. The sample for this purpose is to be taken and forwarded according to rules which are recited at length.

These regulations are to go into effect at least by January 1, 1893.

COÖPERATIVE EXPERIMENTS WITH FERTILIZERS AND TEST OF VARIETIES AT BORSBEKE, NEAR ALOST, BELGIUM, IN 1891, P. DE VUYST (pp. 15).—The experiments here reported were carried out on representative soils of the swampy region of Flanders, and included experiments with fertilizers, tests of varieties, and comparison of methods of culture on meadow grasses, potatoes, beets, and turnips. The results reported are in most cases means of results on triplicate plats, which the author states were sufficiently concordant to permit of conclusions being drawn as to the method of culture, the kind of fertilizer, and the variety which is most likely to succeed in the locality in question. Brief outlines of the experiments with fertilizers and methods of culture are given below:

(1) *Experiments with meadow grasses.*—These were for the purpose of comparing the effects of nitrate of soda and sulphate of ammonia, which were applied in quantities supplying 22.25 pounds of nitrogen per acre. Nitrate of soda gave a profitable return, while sulphate of ammonia was applied at a loss. The author states, however, that it must be remembered in connection with this experiment, as well as with others which follow, that the action of sulphate of ammonia and nitrate of soda depends largely upon the season.

(2) *Experiments with potatoes.*—The fertilizers used in this case were nitrate of soda, sulphate of ammonia, purin, superphosphate of lime, Thomas slag, carbonate of potash, kainit, and farm manure (supplementary), and were applied two by two and all three together on 11 plats containing 35.5 square yards which had previously received an average application of 22,267.2 pounds of farm manure per acre. The fertilizers were applied at a uniform depth 4.78–5.85 inches, except that purin and nitrate of soda in one case each were applied on the surface after the second plowing, and a mixture of nitrate of soda and superphosphate used on one plat was plowed in to a depth of 25 cm. As the nutritive value of potatoes depends entirely upon the dry matter, in which starch is the predominant element, this substance was determined by means of a hydrostatic balance, in samples from each of the plats, and the financial returns calculated upon the basis of yield of starch as well as upon the total yield of tubérs. The highest returns were received from the use of sulphate of ammonia. Nitrates and purin also gave favorable results, while barnyard manure was not remunerative. The superphosphate was also beneficial, but Thomas slag showed little effect. Carbonate of potash was not profitable. Kainit increased the yield at the expense of starch content.

The results of tests of methods of culture were as follows: (1) Close planting gave the highest yield; (2) when half tubers cut through their greatest diameter were used for seed it made no difference whether the cut surface was turned up or down; (3) if the tubers were cut through their smallest diameter, the stem ends (*têtes*) gave the highest yield; (4) ridge culture showed no advantage over flat culture.

(3) *Experiments with beets.*—The preparation of the plats and the application of fertilizers were practically the same as in the preceding experiment, but all the fertilizers were applied at a depth of from 4.78–5.85 inches, except in one case in which the nitrate of soda was applied at the surface. Nitrate of soda gave better results than sulphate of ammonia, and was remunerative both in large and small applications. Superphosphates also proved better than the Thomas slag. Potash in the form of kainit increased the productiveness but reduced the sugar content. The results of this experiment, as well as of the preceding, indicate that the best depth for applying nitrate of soda is 4.78–5.85 inches. The author recommends as a fertilizer for beets a mixture of nitrate of soda, sulphate of ammonia, and superphosphate in the proportion of 0.9 nitrate of soda, 0.675 sulphate of ammonia, and 1.5 of superphosphate.

The best distance for planting seems to be 15.6 by 11.7 inches. Earthing up slightly increased the yield. Partially removing the leaves produced a serious decrease which was not compensated for in the value for forage of the leaves obtained.

(4) *Experiments with turnips.*—These were conducted in almost the same manner as the preceding and the results confirmed those obtained in the last experiment.

The author concludes that the fertilizer likely to give the most profitable returns is a mixture of about 133.2 pounds of nitrate of soda and 267.2 pounds of superphosphate of lime per acre.

THE PATENTS ON THOMAS SLAG.—The German patents under which the Thomas slag phosphate is now manufactured expire within a short time, and the process may then be applied in any iron works. A more universal introduction of this process will naturally result in an increasing production of the phosphate slag. Since the invention of the engineer Thomas in 1879 there has been a steady increase in the production of this slag, as is shown by the following statistics from the *Westpreus. landw. Nachricht.* In 1879 the production was only 12,200 tons; in 1886 it had reached 1,313,631 tons; in 1890, 2,103,082 tons. Up to the close of 1890 not less than 13,449,481 tons were produced. Over half the present annual production comes from Germany and Luxemburg; England produces about 500,000 tons annually; Austria and France between 200,000 and 250,000 tons; and other countries relatively small amounts. This investigation promises to be of benefit to agriculture the world over.

EXHIBIT OF THE WOOL INDUSTRY.—This Department is now taking measures for a thoroughly classified representation of the wool industry of the United States at the World's Columbian Exposition. It is intended to include in the exhibit 100 samples of foreign wool. Of domestic wool about 2,000 samples will be shown of all breeds and crosses raised in the country. The space available for this exhibit will not permit of showing many whole fleeces; these will therefore be restricted to a few taken from pedigreed sheep. Generally speaking, the samples will be put up in glass bottles holding about a pound, and will be so arranged in the bottles as to show on the one side the staple and on the other the skin side of the clip.

DEHÉRAIN'S TREATISE ON AGRICULTURAL CHEMISTRY.—*Comptes rendus*, 114 (1892), pp. 889–891, for April 11, contains an announcement of a *Traité de Chimie Agricole* by Dehérain. The work is divided into three parts. The first part includes chapters on germination; assimilation of carbon, nitrogen, and minerals; respiration and formation of the principal organic products; movement of water in the plant; and growth and maturity. The second part is on soils, mode of formation, physical properties, composition, absorbent properties, and causes of sterility. The third part treats of amendments and fertilizers, fallow, irrigation, lime, marl and plaster; vegetable, animal and mineral fertilizers, and especially farm manures. Prominence is given to the investigations of chemists connected with agricultural experiment stations and laboratories.

IN MEMORIAM.—On April 2, last, Prof. Gustav Kühn of Möckern, Germany, died after a short but severe illness, at the age of 53. Prof. Kühn had been for nearly 25 years director of the experiment station at Möckern and was an exponent of the most advanced investigation in nutrition of farm animals.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING APRIL, 1892

DIVISION OF STATISTICS:

Report No. 94 (new series), April 1892.—Condition of Winter Grain and of Farm Animals; Freight Rates of Transportation Companies.

DIVISION OF CHEMISTRY:

Bulletin No. 32.—Special Report on the Extent and Character of Food Adulterations, and State and other Laws Relating to Foods and Beverages.

Bulletin No. 13, part VI.—Foods and Food Adulterants.

DIVISION OF VEGETABLE PATHOLOGY:

Journal of Mycology, vol. VII, No. 2, March 10, 1892.

DIVISION OF ENTOMOLOGY:

Insect Life, vol. IV, Nos. 7 and 8, April, 1892.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Record, vol. III, No. 9, April, 1892.

Experiment Station Bulletin No. 7.—Proceedings of the Fifth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations.

WEATHER BUREAU:

Monthly Weather Review, January, 1892.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING APRIL, 1892.

AGRICULTURAL EXPERIMENT STATION OF THE AGRICULTURAL AND MECHANICAL COLLEGE OF ALABAMA:
- Bulletin No. 36, March, 1892.—Some Leaf Blights of Cotton.

CANEBRAKE AGRICULTURAL EXPERIMENT STATION:
- Bulletin No. 14, March, 1892.—Cotton.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF ARIZONA:
- First Annual Report, 1890.
- Bulletin No. 5, April, 1892.—Cañaigre.
- Bulletin No. 6, April, 1892.—Soils and Waters.

ARKANSAS AGRICULTURAL EXPERIMENT STATION:
- Bulletin No. 18, February, 1892.—Some Cotton Experiments.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION:
- Bulletin No. 111, March, 1892.—Common Fungous Diseases and their Treatment.

STORRS SCHOOL AGRICULTURAL EXPERIMENT STATION:
- Fourth Annual Report, 1891.

THE DELAWARE COLLEGE AGRICULTURAL EXPERIMENT STATION:
- Bulletin No. 15, January, 1892.—Diseases of Crops and Their Treatment.
- Bulletin No. 16, March, 1892.—Scarlet Clover.

AGRICULTURAL EXPERIMENT STATION OF INDIANA:
- Bulletin No. 39, April, 1892.—Field Experiments with Corn; Sugar Beets; Diseases of the Sugar Beet Root.

IOWA AGRICULTURAL EXPERIMENT STATION:
- Bulletin No. 16, February, 1892.—Flaxseed Meal and Oil Meal; Crop Report for the Farm Department; Varieties of Potatoes; Corn Growing; Experiments with Fungicides; What to Plant on the Home Grounds; Hints for Beginners in Dairying; Lice Affecting Domestic Animals; Sugar Beets.

KANSAS AGRICULTURAL EXPERIMENT STATION:
- Bulletin No. 28, December, 1891.—Second Report on the Experimental Vineyard.
- Bulletin No. 29, December, 1891.—Experiments with Oats.

KENTUCKY AGRICULTURAL EXPERIMENT STATION:
- Second Annual Report, 1889.
- Bulletin No. 36, December, 1891.—Commercial Fertilizers.
- Bulletin No. 37, December, 1891.—Experiments with Potatoes.
- Bulletin No. 38, March, 1892.—Vegetables; Strawberries.
- Bulletin No. 39, March, 1892.—Marls.
- Bulletin No. 40, March, 1892.—Some Common Pests of the Farm and Garden.

LOUISIANA AGRICULTURAL EXPERIMENT STATIONS:
- Fourth Annual Report, 1891.
- Bulletin No. 14 (second series).—Sugar Cane.

MARYLAND AGRICULTURAL EXPERIMENT STATION:
- Special Bulletin F, January, 1892.—Agricultural Outlook for Maryland.
- Special Bulletin G, February, 1892.—Composition of Commercial Fertilizers Sold in the State.

MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION:
- Ninth Annual Report, 1891.
- Circular, March, 1892.—Commercial Fertilizers.

Hatch Experiment Station of the Massachusetts Agricultural College:
- Bulletin No. 17, April, 1892.—Experiments with Fungicides and Insecticides; Notes on Grapes, Peaches, and Siberian Crap Apples.
- Meteorological Bulletin No. 39, March, 1892.

Experiment Station of Michigan Agricultural College:
- Bulletin No. 81, March, 1892.—Fruit Notes.
- Bulletin No. 82, March, 1892.—Sugar Beets.
- Bulletin No. 83, April, 1892.—Insecticides and Fungicides.
- Bulletin No. 84, April, 1892.—Roots *vs.* Silage for Fattening Lambs.
- Bulletin No. 85, April, 1892.—Potato Tests.

Mississippi Agricultural Experiment Station:
- Fourth Annual Report, 1891.

Agricultural Experiment Station of Nebraska:
- Bulletin No. 20, March 25, 1892.—Meteorological Observations for 1891.

Nevada Agricultural Experiment Station:
- Fourth Annual Report, 1891.
- Bulletin No. 15, January, 1892.—Dodder.

New Hampshire Agricultural Experiment Station:
- Bulletin No. 15, December, 1891.—Patent Cattle Foods.

New Jersey Agricultural Experiment Stations:
- Bulletin No. 86, April 1, 1892.—Spraying for Insect and Fungous Pests of the Orchard and Vineyard.
- Special Bulletin O, April 6, 1892.—Experiments with Nitrate of Soda upon Tomatoes.
- Special Bulletin P, April 9, 1892.—Experiments with Fertilizers upon White and Sweet Potatoes.

Agricultural Experiment Station of New Mexico:
- Second Annual Report, 1891.
- Bulletin No. 4, December, 1891.—Trees; Vegetables.

North Carolina Agricultural Experiment Station:
- Bulletin No. 80*c*, November 15, 1891.—Meteorological Summary for October, 1891.
- Bulletin No. 83*a*, February 20, 1892.—Meteorological Summary for January, 1892.

North Dakota Agricultural Experiment Station:
- First Annual Report, 1890.
- Second Annual Report, 1891.

Oregon Experiment Station:
- Bulletin No. 18, March, 1892.—Insects Injurious to Young Fruit Trees; Codling Moth; Wireworms; Flea Beetles.

South Dakota Agricultural Experiment Station:
- Bulletin No. 28, December, 1891.—Irrigation.

Agricultural Experiment Station of Utah:
- Bulletin No. 11, April 1, 1892.—Blanketing Horses and Cattle; Sheltered *vs.* Unsheltered Cattle; Exercise *vs.* No Exercise for Stock.
- Bulletin No. 12, March, 1892.—Experiments with Garden Vegetables.

Washington Agricultural Experiment Station:
- Bulletin No 3, February, 1892.—Report of Farmers' Institute held at Garfield, Washington.

West Virginia Agricultural Experiment Station:
- Bulletin No. 22, February, 1892.—Weeds of West Virginia.

DOMINION OF CANADA.

Ontario Agricultural College Experiment Station:
- Bulletin No. 73, April 8, 1892.—Fungicides and Insecticides.

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U. S. DEPARTMENT OF AGRICULTURE

OFFICE OF EXPERIMENT STATIONS

A. W. HARRIS, DIRECTOR

EXPERIMENT STATION RECORD

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EXPERIMENT STATION RECORD.

Vol. III. ISSUED JUNE, 1892. No. 11.

EDITORIAL NOTES.

The Division of Vegetable Pathology of this Department is preparing an Index to Mycological Literature, which promises to be of great value to all students of fungi. This index is being published in installments in the Journal of Mycology. It has hitherto been confined to American literature, but in volume VII, No. 2, of the Journal, recently issued, its scope has been widened to include foreign literature. The arrangement of the entries is also changed. The articles are no longer placed in strictly alphabetical order, but are grouped under subjects, which are classified as follows:

A.—Works of a general nature.
B.—Diseases of non-parasitic or uncertain origin.
C.—Diseases due to fungi, bacteria, and Myxomycetes.
- I.—Relations of host and parasite.
- II.—Diseases of field and garden crops.
- III.—Diseases of fruits.
- IV.—Diseases of forest and shade trees.
- V.—Diseases of ornamental plants.

D.—Remedies, preventives, appliances, etc.
E.—Physiology, biology, and geographical distribution.
F.—Morphology and classification of fungi.
- I.—General works.
- II.—Chytridiaceæ.
- III.—Oömycetes.
- IV.—Zygomycetes.
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- VII.—Ustilagineæ.
- VIII.—Ascomycetes.
  - (1) Gymnoasci.
  - (2) Perisporiaceæ.
  - (3) Sphæriaceæ.
  - (4) Discomycetes.
- IX.—Imperfect and unclassified forms.
  - (1) Hyphomycetes and Stilbeæ.
  - (2) Sphæropsideæ and Melanconeæ.
  - (3) Miscellaneous.

G.—Morphology and classification of bacteria.
H.—Morphology and classification of Myxomycetes.
I.—Exsiccati.
J.—Technique.

The advantage of this arrangement is that all references to particular subjects are grouped together instead of being scattered through the index. For example, the entries on diseases of fruits are indexed together alphabetically according to authors, with cross-references to other articles which treat of fruit diseases only as a matter of secondary importance. The section relating to preventives, remedies, etc., it may be said incidentally, occupies more space than any other in the present number of the Journal, covering nine closely printed pages. The following extract from the announcement of the change in the index will be of especial interest to the stations:

The index is designed especially to aid experiment station workers and others in this country who do not have access to the more important literature on plant diseases and allied subjects. In order to make the index more valuable, especially as regards accessibility, it is suggested that the various items be cut out, pasted on cards, and then arranged alphabetically, according to authors and subjects. For this purpose we use the Library Association's standard cards No. 32, 5 by 12.5 centimeters. By adopting this method new cards may be inserted at any time, thus making it possible to keep all of one author's writings together or all that has been written on any one subject.

The cards thus prepared can, if desired, be put with those of the General Index of Agricultural Literature prepared by this Office. In this case special division cards should be used for the subdivisions under Diseases of Plants (5.6).

We commend the index to the attention of the stations, and suggest that in order to assist in making it complete copies of all station publications containing articles relating to fungi be sent as soon as issued to the Division of Vegetable Pathology.

Several of the stations have issued indexes to series of their publications. This is a useful thing to do, and it is to be hoped that it will become a general practice. While this matter is in its formative stage we wish to urge the desirability of a certain degree of uniformity in the preparation of these indexes. On the whole it seems best that each indexed volume should consist of the publications of a single year. In this way all references to these volumes may be made by citing the year of publication. For example, if a scientific journal cites an experiment by the Kansas Station, the reference would most conveniently read: Kansas Station Report for 1892. Any other arrangement is likely to lead to confusion. A little attention to the matter would also enable the several stations to index the great mass of their material under categories stated in the same phraseology. The student who has had occasion to look up hundreds of references on any subject will appreciate what trouble is made by the necessity of conjecturing in what

particular phrases the indexer has seen fit to clothe his categories. The investigator should not be compelled to read the entire index to be sure that he has not missed what he desires to find. The style and arrangement of the index are also worthy of serious consideration. There are principles and rules of indexing which should be strictly observed. A good index is a valuable labor-saving machine, and its style and finish are worthy of as much thought as the farmer gives to the pattern of his mowing machine or his plow.

Having been recently engaged in an attempt to complete our files of station publications, we are more than ever convinced of the desirability of some simple and uniform plan of numbering the current bulletins. Where fractional numbers or numbers combined with letters are introduced, or the same numbers are repeated in several series, it is impossible to tell when a complete set has been secured. If there are 10*a* and 10*b*, and 11*a*, 11*b*, 11*c*, and 11*d*, and 12*a*, who can tell whether there will be 12*b* and 12*c*? Or, if the series runs 1, 2, 3, $3\frac{1}{2}$, 4, $5\frac{1}{4}$, $5\frac{1}{2}$, how shall we know whether there is $5\frac{3}{4}$ or not? A bulletin marked No. 71 is easy enough to find, but vol. III, No. 6 (tenth series), may be untraceable, especially if after a while the number of the series is omitted.

Our attention has been called by one of the station officers to the desirability of greater uniformity in the size of the pages of station publications. It was recommended in the report of a special committee adopted by the Association of American Agricultural Colleges and Experiment Stations at its Knoxville convention (see Miscellaneous Bulletin No. 1 of this Office, p. 110) that the bulletins and reports "be uniform in size, $5\frac{3}{4}$ by 9 inches, and not to deviate from this measurement more than one quarter of an inch when trimmed."

It is gratifying to observe that more attention is being given to the paper and type of the station publications. The number of illustrations is increasing and their quality is being improved. The importance of putting bulletins intended for the farmer in attractive form was strongly urged at the last meeting of the Association of American Agricultural Colleges and Experiment Stations by Professor Roberts in an address, from which the following sentences are taken:

> In the first place the bulletin must be respectable because a farmer likes things which are respectable. The neater it is, the better the paper, and the more artistic it is in its presswork, the better he will like it. * * * To reach the farmers we must illustrate, using more pictures and less words, more lines of different angles and less figures.

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Alabama Canebrake Station, Bulletin No. 14, March, 1892 (pp. 10.)

COTTON EXPERIMENTS, W. H. NEWMAN, M. S.—The results are tabulated for cotton raised on acre plats under the following conditions: On drained and undrained land manured with 2,000 pounds of green cotton seed per acre; on drained and undrained land without manure and with 400 pounds of cotton-seed meal per acre; on drained land manured with 200 and with 400 pounds of cotton-seed meal applied all at one time and in separate portions; on undrained land previously used for melilotus and for peas; on undrained land with 18 tons of barn-yard manure per acre; and on drained land checked 4 by 4 feet, one stalk to a hill. "The increased yield by the application of a ton of seed on the undrained land was 156.5 pounds of lint cotton, which paid for the cost of the seed and the cost of application. The increased yield on the drained land was only 40.5 pounds. * * * The acre in melilotus produced 11.48 pounds more seed cotton per acre than the acre in peas." The barnyard manure "was about two thirds sawdust, which probably prevented a profitable effect."

Tabulated notes are given for 15 varieties of cotton. The results of tests with commercial fertilizers for cotton "verified the conclusions of the last 5 years, that commercial fertilizers are not profitably used upon this class of soils."

Arkansas Station, Fourth Annual Report, 1891 (pp. 16).

This includes brief statements regarding the work of the station in different lines, and a financial report for the fiscal year ending June 30, 1891.

Arkansas Station, Bulletin No. 18, February, 1892 (pp. 16).

SOME COTTON EXPERIMENTS, R. L. BENNETT, B. S. (pp. 3–15).

Cotton seed for fertilizing vs. selling (pp. 3, 4).—This experiment was designed to ascertain if it is not more profitable to use cotton seed as a fertilizer than to sell it at $6.50 a ton delivered, which is the price said to be paid in small towns or those without oil mills. Five hundred

pounds of rotted seed was applied to 1 acre of cotton and another acre received no seed. The yield and value of the crops from both acres are stated.

"From the use of the 500 pounds of seed per acre, costing $1.62 at the rate of $6.50 per ton, the profit is $3.93; or in other words, if a ton of seed costing $6.50 had been applied to 4 acres at the rate of 500 pounds per acre the profit would have been $15.72."

Cotton seed vs. cotton-seed meal as a fertilizer (pp. 4, 5).—The yields and financial results are given of raising cotton with the use of cotton seed and of cotton-seed meal, each applied at the rate of 500 pounds per acre. The cotton seed is quoted at $6.50 per ton and cotton-seed meal at $20 per ton. At these prices there was practically no difference in the financial results from using the two materials.

Rotation experiment (pp. 5, 6).—Results are tabulated for the first and second year of a rotation experiment with cotton, corn, field peas, and barley.

Soil test with fertilizers (pp. 6–10).—In this soil test cotton-seed meal, kainit, and acid phosphate, 500 pounds of each, were applied separately on 3 twentieth-acre plats and 1 plat remained unmanured. The largest yield of seed cotton, 199 pounds per acre, was obtained with cotton-seed meal.

Comparative value of varieties (pp. 10–13).—The results are tabulated and discussed for 11 varieties of cotton raised at the station, and the results are given of tests of varieties made by the Louisiana, Mississippi, and Georgia Stations.

Bottom and top bolls (p. 14).—Determinations were made of the seed cotton, seed, lint, and staple from 500 mature bolls of Peerless cotton picked from the top and 500 from the bottom of the stalk. According to the data given "the top bolls are far inferior in production to the bottom bolls; 500 bottom bolls correspond to 637 top bolls."

Cotton culture (pp. 14, 15).—Brief remarks are made on the distance of planting cotton, and on deep and shallow culture for cotton.

BARLEY AND RYE (p. 16).—The yields are given of barley and rye planted for green soiling on plats without fertilizers and on those in which pea vines had been plowed under. The yields of both were considerably larger on the plat where pea vines were used.

Connecticut State Station, Annual Report, 1891 (pp. 208).

REPORT OF BOARD OF CONTROL (pp. 9–11).—A brief outline of the work of the station during the year.

REPORT OF TREASURER (p. 12).—A statement of receipts and expenditures during the fiscal year ending June 30, 1891.

FERTILIZERS (pp. 13–95).—This includes among other things the text of the Connecticut fertilizer law, a list for the year of the fertilizer dealers complying with the law, popular explanations concerning the analysis of fertilizers and the valuation of their ingredients for 1891,

and analyses of 281 samples of fertilizers and fertilizing materials, including nitrate of soda, nitrate of potash, ammonium sulphate, cotton-seed meal, castor pomace, dissolved boneblack, double sulphate of potash and magnesia, sulphate and muriate of potash, bone, tankage, bat guano, home mixtures, cotton-hull ashes, wood ashes, substitutes for wood ashes, limekiln ashes, rag dust, ashes from brass works, hen manure, beef scrap, and muck, and a review of the fertilizer market for 1891.

Of the 57 brands of nitrogenous superphosphates here reported, 14 are below their minimum guaranty in respect of one ingredient and 6 in respect of two ingredients; that is, one third of all the nitrogenous superphosphates in our market contain less of one or of several ingredients than they are claimed to contain. * * *

The average cost of the nitrogenous superphosphates, as already given, is $33.93, the average valuation $28.13, and the percentage difference 20.6. * * *

[Of 43 brands of special manures] 11 are below the maker's guaranty in respect of one ingredient and one brand is below in all three. * * *

The average cost per ton of the special manures has been $38.84, the average valuation $31.64, and the percentage difference 22.8, a little higher than in case of the nitrogenous superphosphates. * * *

Comparing the home mixtures with the special manures, it is seen that the former contain on the average (14 analyses) 0.5 per cent more nitrogen, over 1.5 per cent more phosphoric acid, and slightly more potash than the latter. * * *

The average cost of the materials (delivered) of which these mixtures were made, without the special discounts which were obtained in some cases, was $34.47. To this must be added the cost of screening and mixing, which is necessarily variable and is estimated by those who have had experience at from $1 to $2 per ton.

If the average cost of the mixed materials is placed at $37 per ton, it will probably fully cover all expense in every case.

An article on substitutes for unleached ashes is reprinted from Bulletin No. 110 of the station (see Experiment Station Record, vol. III, p. 601).

Observations on a herd of milch cows (pp. 96–106).—These observations, extending from November to April, were made on 19 native cows about 2 or 3 months in milk at the beginning of the trial. The milk from each milking was weighed and samples taken for testing. The data recorded include the average yields of milk and fat and the percentage of fat; the yields of milk and butter fat for individual cows during the 6 months; the amount, cost, and manurial value of the food; and pounds of nitrogen, phosphoric acid, and potash in the food, milk, and manure of one cow for 4 months. Some interesting facts were brought out with regard to the relative profitableness of the individual cows.

Here are two cows costing the same for feeding and care; the better of the two is 2 months older in milk than the poorer, and while the one gives 10.4 quarts per day for the 6 months, the other gives only 7 quarts, a difference of 3.4 quarts per day or for the 6 months 615.4 quarts, or more than $40 worth of milk.

Roughly figured, the difference in the yield of fat would make a difference of 50 pounds of butter in the 6 months. * * *

In comparing the average ration of the herd with the standard, it appears that the cows have had an abundance of food—25 pounds per day of organic matter as against

24 of the standard; but it also appears that while they have had 1.2 pounds more carbohydrates (starch, sugar, fiber, etc.) and 0.2 pound more fat than the standard requires, there has been 0.5 pound less per day of the albuminoids, or "flesh formers"—only four fifths of the quantity required by the standard.

Of course the feeding standard is a general statement, represents an average, and is not to be too literally taken. It is only a general guide, but the above comparison suggests the inquiry whether the ration fed was not seriously deficient in albuminoids and wasteful of the carbohydrates.

THE BABCOCK METHOD OF DETERMINING FAT IN MILK (pp. 107-111).—This article is reprinted from Bulletin No. 106 of the station (see Experiment Station Record, vol. II, p. 630).

MISCELLANEOUS NOTES ON MILK (pp. 112-114).—These notes include analyses of the milk brought by different patrons of creameries, analyses of the mixed milk of a herd, analyses of milk showing the effect of sickness on the yield and composition, determinations of the fat in the first of the milking and in the strippings, and comparative determinations of the solids in milk by drying the milk alone and on sand. "In thirteen tests the extreme difference between the results by the two methods was 0.17 per cent and the average difference 0.08 per cent, and in eleven out of thirteen cases the sand method gave a lower result."

DETERMINATION OF THE FAT IN CREAM BY THE BABCOCK METHOD (pp. 115-120).—This is mainly a reprint from Bulletin No. 108 of the station (see Experiment Station Record, vol. III, p. 144), but contains in addition the results of six comparative tests, using the pipette described by Winton in this article, and the test bottle and pipette described by J. M. Bartlett in Bulletin No. 3 (second series) of the Maine Station (see Experiment Station Record, vol. III, p. 397).

ON VARIATION IN THE COMPOSITION OF CREAM RAISED BY DEEP SETTING AT LOW TEMPERATURES (p. 120).—These observations were made on cream collected from creamery patrons who set their milk in deep submerged cans for from 12 to 24 hours before it was collected by the cream gatherer.

Thirty-seven tests, made at two creameries, gave an average of 27.55 per cent of solids. The highest per cent found was 31.18, the lowest 25.18.

One hundred and sixty-five tests made at three creameries in different parts of the State gave for the average 19.85 per cent of fat. The highest per cent found was 24.9, the lowest 13.8 per cent.

The widest variations in the per cent of fat in the cream furnished by individual patrons of one creamery on the same day were 13.8-21 per cent and in another case 18.3-24.9 per cent. The smallest daily variations at any one creamery were 19-21.9 per cent.

THE COMPOSITION OF CREAM AND BUTTERMILK, AND THE LOSS OF BUTTER FAT IN CHURNING (pp. 120, 121).—An account of a single test made at a creamery. Analyses are given of the cream and products of churning, and a statement of the total number of pounds of ash, fat, albuminoids, sugar, and water in the same; 87.89 pounds of fat were put into the churn and 86.59 pounds of butter fat recovered in

the butter. There was a loss of 0.6 pound of butter fat in the buttermilk and washings, equal to 0.68 per cent of the total quantity of the fat in the cream.

BUTTER ANALYSES (pp. 122, 123).—Analyses are given of eleven samples of butter from private dairies and six samples of creamery butter which were exhibited at a meeting of the Connecticut Dairymen's Association in January, 1891, together with the score of points for each butter. As a rule the creamery butter scored more points than samples from private dairies.

The private dairy butters which received the lowest grading for flavor, grain, and salt were ones which had the very abnormally high per cent of salt (6.78 and 7.83). * * * The creamery butter as a rule carried 3 per cent more of actual butter fat than the private dairy butter.

PROTEIDS OR ALBUMINOIDS OF THE OAT KERNEL, T. B. OSBORNE, PH. D. (pp. 124–135).—In his first paper on this subject, published in the Annual Report of the station for 1890 (see Experiment Station Record, vol. III, p. 11), the author described a globulin obtained from the oat kernel by extraction with a 10 per cent sodium chloride brine heated to 65° C. This globulin differed from that extracted by the same brine at 20° C. both in properties and composition, and crystals were obtained in several instances when the warm saturated solution of this body in dilute sodium chloride brine was cooled. This has been further investigated and the results obtained form the main subject of the second paper. The preparation is described of a globulin from the so-called albuminate contained in cold brine extract after treatment with ammonium sulphate, and which was insoluble in 10 per cent salt solution but soluble in a 1 per cent sodium carbonate solution. The globulin was prepared from the albuminate (1) by precipitating the solution of the albuminate in a 1 per cent sodium carbonate solution with carbon dioxide, dissolving the precipitate in brine, dialyzing for 4 days, filtering off the precipitated proteid, and washing with alcohol, ether, and absolute alcohol; and (2) by precipitating the solution of the albuminate in 2 per cent sodium carbonate solution with carbon dioxide, washing thoroughly with water, dissolving in brine, reprecipitating by dilution with a large amount of water, and washing the final snow-white precipitate with alcohol and ether. The proteids obtained by both processes behaved exactly like the globulin obtained by extracting ground oats with hot brine, except with regard to solubility in hot and cold water. Analysis indicated the two bodies to be identical in composition. Crystals of the globulin prepared from the so-called albuminate were obtained from a saturated solution of the globulin in 1 per cent sodium chloride solution, which in some cases were octahedral and in others rhombohedral. A globulin was also obtained by direct extraction of ground oats with 1 per cent sodium carbonate solution, the extract being successively treated with carbon dioxide saturated with ammonium sulphate, reprecipitated, filtered, and washed with a saturated ammonium sulphate solution, thoroughly extracted with salt solution, dialyzed, and

purified by washing with alcohol and ether. Analysis indicated this body to be the same as that obtained from the oats by direct extraction with hot salt solution and from the so-called albuminate by the methods described above.

The precipitate produced by saturating with ammonium sulphate the sodium carbonate extract of oats from which the globulin had been removed, was thoroughly washed with warm 80 per cent alcohol, dissolved in two-thirds per cent caustic potash solution, the solution filtered, and the dissolved proteid precipitated by neutralizing with dilute acetic acid. Analysis showed this preparation to agree quite closely in composition with that which was obtained from ground oats by direct extraction with 2 per cent potash solution.

As the result of his studies of the proteids of the oat kernel the author arrives at the following conclusions:

The proteids of the oat kernel undergo great change in contact with water or sodium chloride solution. The body extracted by direct treatment of ground oats with alcohol differs much in properties and composition from that extracted by alcohol after the ground oats have had contact for some time with water or sodium chloride solution.

Direct treatment with sodium carbonate solution yields the same globulin as that obtained by direct treatment with hot sodium chloride solution, but a different globulin from that obtained by direct treatment with cold sodium chloride solution. Sodium carbonate solution also extracts another proteid the same as that yielded by direct extraction with dilute potash lye, which again is distinct in composition from that obtained after the oats have been in contact with water. It is remarkable that all these transformations are the result of the use of water or salt solution as contrasted with the use of three agents known to suspend or destroy ferment action, viz, alcohol, alkali, and heat.

The fact that the globulin extracted after treatment of the ground oats with alcohol has the same composition as that obtained by direct treatment with sodium chloride, would indicate that alcohol temporarily suspends a ferment action which is induced by water or solutions of neutral salts.

It is probable that the primary proteids originally contained in the oat kernel are the three following bodies:

Primary oat proteids.

	Alcohol-soluble proteid (average of 5 analyses).	Salt-soluble proteid or globulin (average of 9 analyses).	Alkali-soluble proteid (average of 2 analyses).
Carbon	53.01	52.19	53.56
Hydrogen	6.91	7.00	7.09
Nitrogen	16.43	17.86	16.20
Sulphur	2.26	0.65	0.90
Oxygen	21.39	22.30	22.25
	100.00	100.00	100.00

Of the above substances the alcohol-soluble proteid forms about 1.25 per cent, the globulin about 1.5 per cent, and the alkali-soluble body the remainder of the proteids contained in the oat kernel, with the possible exception of extremely small amounts of proteose and acid albumin. The two latter substances are quite probably the results of change occurring during extraction; the evidence on this point, however, is not conclusive.

Three other proteids are obtained, evidently by the alteration of the primary proteids, and probably through ferment action, when the ground oats are subjected to contact with water or solutions of neutral salts. The composition of these derived or secondary proteids is as follows:

Secondary oat proteids.

	Alcohol-soluble proteid (average of 4 analyses).	Salt-soluble proteid or globulin (average of 4 analyses).	Alkali-soluble proteid (average of 2 analyses).
Carbon	53.70	52.34	52.49
Hydrogen	7.00	7.21	7.10
Nitrogen	15.71	16.88	17.11
Sulphur	1.76	0.88	0.80
Oxygen	21.83	22.69	22.50
	100.00	100.00	100.00

It would appear that none of the proteids from the oat kernel have been obtained and analyzed in a state of purity by previous investigators. The author therefore reserves the right to revise the nomenclature of these bodies after further progress in his researches on the other vegetable proteids, with which he is now engaged.

PROTEIDS OF THE MAIZE KERNEL, R. H. CHITTENDEN AND T. B. OSBORNE, PH. D. (pp. 136–138).—This is a brief summary of the results of an extended investigation of the proteids of Indian corn during 1890 and 1891 in the Sheffield Biological Laboratory of Yale University, the details of which are published in the *American Chemical Journal*, vol. 13, pp. 453, 529, and vol. 14, p. 20. The corn used was a white dent variety.

(1) The maize kernel contains several distinct proteids well characterized in reactions and composition. Of these there are three globulins and one or more albumins, all occurring in small proportion, and an alcohol-soluble proteid which is relatively abundant.

(2) The substance obtainable from the maize kernel by extraction with 10 per cent solution of sodium chloride and separation by dialysis, or by precipitation with ammonium sulphate, followed by dialysis, is mainly a mixture of two globulins, differing from each other in composition and in coagulation points.

(3) The mixed globulins can be approximately separated from each other by fractional heat coagulation or by deposition from warm dilute salt solution. In the former process there is formed a small amount of proteose-like bodies.

(4) The two globulins, separable by the above methods, are a myosin-like body and a vitellin-like body.

The myosin-like globulin closely agrees in composition with animal myosin. It has, however, a coagulation point (in 10 per cent sodium chloride solution) of about 70° C. * * *

The vitellin-like globulin is almost entirely non-coagulable by heat when dissolved in dilute salt solutions. It is more soluble in warm than in cold salt solutions, and when separated from the former either by cooling the fluid or on dialysis, it almost invariably appears in the form of small spheroids.

(5) These two globulins exist as such in the maize kernel, as is evident from the coagulation points of their salt solution, from the fact that their separation can be accomplished without the aid of heat, and lastly, since it is possible to extract the individual globulins directly from the kernel by the use of appropriate solvents.

(6) Direct extraction of the finely powdered maize meal with water yields a dilute salt solution which dissolves the myosin, leaving the bulk of the vitellin undissolved.

Probably the character of the salts present in the kernel plays an important part in this separation. From this solution the myosin can be separated in a fair degree of purity by the usual methods.

(7) Extraction of maize meal with 10 per cent sodium chloride solution, after previous extraction with water, dissolves the vitellin, which can be separated from this solution by the customary methods. So prepared, it agrees exactly in composition with the vitellin separated by heat coagulation from the mixed globulins.

(8) The third globulin present in the maize kernel is characterized by extreme solubility in very dilute salt solutions, especially of phosphates and sulphates. It separates from such solutions only by prolonged dialysis, *i. e.* not until nearly every trace of the salts has been removed. It coagulates in a 10 per cent sodium chloride solution in the neighborhood of 62° C.

	Maize myosin (average of 2 analyses).	Maize vitellin (average of 6 analyses).	Maize globulin (highly soluble).
Carbon	52.66	51.71	52.38
Hydrogen	7.02	6.85	6.82
Nitrogen	16.76	18.12	15.25
Sulphur	1.30	0.86	1.26
Oxygen	22.26	22.46	24.29
	100.00	100.00	100.00

(9) Through the long-continued action of water and also of strong solutions of salts, as ammonium sulphate, the myosin and the globulin noticed in the preceding paragraph are changed into insoluble modifications, soluble, however, in 0.5 per cent sodium carbonate solution, from which solution they are precipitated on neutralization, apparently as albuminates. So prepared, these insoluble modifications are characterized by a relatively high content of carbon.

(10) An aqueous extract of maize meal, as well as a sodium chloride extract, apparently contains in addition to the globulins two albumin-like bodies, more or less coagulable by heat, but, as prepared, unlike in chemical composition. Owing to the difficulties encountered in separating these albumins, their composition could not be determined with certainty.

(11) A small amount of proteose can be detected in the extracts of maize meal after the globulins have been entirely removed, but apparently this is mainly if not wholly an artificial product, resulting from alteration of some one or more of the preceding bodies.

(12) The chief proteid in the maize kernel is the peculiar body known as maize fibrin or better as zein, which is soluble in warm dilute alcohol, but insoluble both in water and in absolute alcohol. Zein is characterized by a high content of carbon by its resistance to the action of dilute alkalies (*i. e.* nonconvertibility into alkali-albuminate), and by the ease with which it is converted into an insoluble modification on being warmed with water or with very weak alcohol.

Soluble zein and its insoluble modification have the same chemical composition, as indicated by the following analyses:

	Soluble zein (average of 6 analyses).	Insoluble zein (average of 3 analyses).
Carbon	55.28	55.15
Hydrogen	7.27	7.24
Nitrogen	16.09	16.22
Sulphur	0.59	0.62
Oxygen	20.77	20.77
	100.00	100.00

Observations on the growth of maize continuously on the same land (pp. 139–149).—These statistics are given for crops of corn raised in 1888–91 on 4 plats, each containing 0.3 of an acre. In 1888 and 1889 all the plats received the same commercial fertilizer, and the quantity of crop removed was practically alike for all. In 1890 and 1891 plat A received cow manure at the rate of about 10 cords per acre, plat B hog manure at the rate of about 13.5 cords per acre, plat C a complete fertilizer mixture at the rate of 1,700 pounds per acre, and plat D received no fertilizer. The yields of corn on the different plats are given, together with the food and fertilizing ingredients contained in the crop, and the amounts of fertilizing materials applied to the soil. From these data calculation is made of the enrichment or impoverishment of the soil by 4 successive years of manuring and cropping.

The gross yield of kernels and of total crop on plats A and B, which received a heavy dressing of manure, is practically the same, the difference being less than 3 per cent. The stover on these plats differs by about 6 per cent, being largest on plat A where cow manure was used.

Plat C, which had received fertilizer chemicals, gave less gross yield than plat A by somewhat more than 8 per cent.

Plat D, which for 2 years has had no fertilizer of any kind, produced a crop weighing about 62 per cent of the weight of the crop harvested from the plats which had been heavily manured for the last 2 years. * * *

The production of each food ingredient was greatest on plat A and least on plat D. There was more water in the harvested crop on plat C than in that of any other plat. [An error in weighing the subsamples from this plat is suspected.]

While the albuminoids make up 7.47 and 7.61 per cent respectively of the whole dry matter of the crops on plats A and B, they make only 6.05 per cent of the crop on plat D. * * * There are no striking differences in the per cent of fat and fiber in the crops from the different plats; the per cent of ash in the kernels from the different plats is practically the same; in the stover it is noticeably lower on plats C and D. Nitrogen-free extract is 1 per cent higher in the kernels from plat C and 2 per cent higher than those from plat D than in kernels from plats A and B. * * *

The dry matter of the kernels from plats A and B, the heavily manured plats, contained in round numbers 1 per cent more protein than the kernels from plat C, which received commercial fertilizers and 2 per cent more than those of plat D, which had no fertilizer.

The application of fungicides for leaf spot of quinces, R. Thaxter, Ph. D. (pp. 150–152, plate 1).—An account of experiments in continuation of those recorded in the Annual Report of the station for 1890 (see Experiment Station Record, vol. III, p. 10). In the spring of 1891 the favorable effect of the application of fungicides the previous year was seen in the greater number of blossoms on the treated shrubs. Bordeaux mixture and precipitated carbonate of copper (instead of the ammoniacal solution used the previous season) were the fungicides used in 1891. Applications were made May 11 and 28 and June 22. "Owing to the unusually dry summer, a fourth application was unnecessary, the Bordeaux mixture adhering so firmly that it

was conspicuous on the leaves late in September." The yields of baskets of marketable fruit from the rows used in the experiments of 1890 and 1891 were as follows: Two rows sprayed with Bordeaux mixture, 71.5; two rows sprayed with ammoniacal carbonate of copper (1890) and with precipitated carbonate of copper (1891), 7; five untreated rows, 1. The expense of treating the two rows with Bordeaux mixture was \$4.20. The 71.5 baskets of fruit from these rows were sold for \$53.62, leaving a profit of \$49.42. The results of the treatment with Bordeaux mixture are clearly shown in the plate accompanying the text.

The superiority of the fruit from the rows sprayed with Bordeaux mixture as compared with that from the other treated rows in regard to the quality, was quite remarkable. While the yield from the carbonate of copper rows was very fair as regards quantity, the fruit was so badly injured by the spot and more especially by being "wormy," that only the very small quantity of fruit above stated was found to be marketable. The apparent effectiveness of the Bordeaux mixture in keeping off the quince "maggot" suggests the advisability of using an insecticide with the fungicide in the first two treatments, as is often done in spraying for the codling moth and apple scab. * * *

The application of the fungicide in the present case was made much more effective than in the previous year, and a perfectly even distribution of the material insured by means of a plunger, which was worked in the barrel by the person who pumped. This consisted of a broomstick with a short piece of board screwed on the end and was worked through a small hole bored in the top of the barrel.

POTATO SCAB, R. THAXTER, PH. D. (pp. 153–160).—Culture and infection tests in 1891, similar to those recorded in the Annual Report of the station for 1890 (see Experiment Station Record, vol. III, p. 9), confirmed the previous observations of the author regarding the fungous nature of potato scab. The author is inclined to believe that the "deep" and "surface" forms of the scab are simply variations of the same disease. Reference is made to the investigations of the fungus and a bacterium associated with potato scab, by H. L. Bolley, M. S., as reported in Bulletin No. 4 of the North Dakota Station (see Experiment Station Record, vol. III, p. 619). In connection with the artificial infection of growing tubers with the pure scab fungus, an attempt was made to inoculate tubers with a fungus mentioned in the Report for 1890 and doubtfully referred to *Oospora perpusilla* by Saccardo. "Pure cultures of this fungus were obtained from horse dung, on which it always appears as a whitish coating, but when transferred to the potato tubers no effect whatever was produced."

Sulphur and muriate of potash used as fertilizers in a field experiment did not reduce the amount of scab on tubers grown on infected land.

On a piece of new land on the station grounds 178 hills of potatoes were planted. The methods and results of the treatment were as follows:

Set a, twenty-eight hills, planted with scabbed seed known to be attacked by the scab fungus, every second hill unfertilized, the rest fertilized with mixed fertilizer; 66.5 per cent scabbed badly in all hills.

Set b, twenty-eight hills planted with clean Beauty of Hebron seed; every second hill unfertilized, the rest fertilized with manure from a horse fed on hay and oats; 5 per cent scabbed in hills containing manure.

Set c, twenty-eight hills planted as in *set b,* but every second hill fertilized with manure from a horse fed on oats in which pure cultures of the scab fungus had been mixed; 50 per cent scabbed in hills containing manure.

Set d, fourteen hills planted as in *b,* with addition of a trowelful of oxide of iron in the alternate hills, every second hill fertilized with mixed fertilizer; 8 per cent scabbed in hills treated with oxide of iron; 2 per cent scabbed in alternate hills.

Set e, fourteen hills planted as in *b,* the alternate hills containing broken plaster and cement, the rest mixed fertilizer; 60 per cent scabbed in hills containing plaster, etc.; 6 per cent scabbed in alternate hills.

Set f, twenty-two hills, every other row planted with scabbed seed from La Fayette, Indiana (unfertilized), the rest as in *set b,* unfertilized; 50 per cent scabbed in hills containing La Fayette seed; 4 per cent scabbed in alternate hills.

Set g, twenty-eight hills planted as in *b,* the alternate rows fertilized with wood ashes, the rest with commercial fertilizer; 7.5 per cent scabbed in hills containing wood ashes; 12.5 per cent scabbed in alternate hills.

As far as so small an experiment is of value the results seem to show that in clean land, in which about 6 per cent only of the crop of potatoes would be normally scabbed, (1) scabbed seed very greatly increases the number of diseased tubers produced; (2) barnyard manure which has not been contaminated by the scab fungus, either by food ingested or otherwise, may not materially increase the amount of scab; (3) oxide of iron in amount sufficient to color new tubers red exerts no appreciable influence on the amount or virulence of scab; (4) plaster and cement, for some reason not apparent, exercise a very decided influence, especially upon the virulence of the disease, which was worse in these hills than in any others; (5) wood ashes have no apparent connection, as has been suggested, with the presence of the disease.

Although the hills fertilized with barnyard manure from a horse fed with pure culture of the scab fungus show a decided increase in the amount of scab, the experiment can hardly be considered a fair one, as the cultures in question consisted almost wholly of the vegetative mycelium of the fungus, so that comparatively few spores were ingested, and the purely vegetative hyphæ may have been killed in the digestive tract, such spores as were present alone surviving, and perhaps multiplying only to a limited extent in the feces after evacuation. The reverse would be true where scabbed potatoes, on which the spore formation is always very abundant, were fed to stock, and the writer is convinced that the practice of feeding diseased tubers in this way is one of the most important means by which the disease is spread on farms. * * *

The condition of the hills treated with plaster and cement was very striking, the scabs upon the tubers being unusually deep and widespread and the gray appearance produced by the fungus very conspicuous.

The potato scab fungus is described as follows:

Oospora scabies, nov. sp.—Vegetative hyphæ brownish 0.06–1 μ in diameter, curving irregularly, septate or pseudoseptate, branching. Aerial hyphæ at first white, then gray, evanescent, breaking up into bacteria-like segments after having produced single terminal spiral spores (?) by the coiling of their free extremities. Forming a firm lichenoid pellicle on nutrient jelly and usually producing a blackish brown discoloration of the substratum on which it grows, causing the disease known as "scab" on potato tubers and a similar disease of beet roots (sec. Bolley).

The fungus is referred to *Oospora* merely for the reason that it appears more nearly allied to certain forms included in this genus by Saccardo than any others known to the writer. There seems to be, however, at least one and perhaps several saprophytic forms, having the same morphological characters, which may prove constant enough to warrant a new generic designation.

THE CONNECTICUT SPECIES OF GYMNOSPORANGIUM (CEDAR APPLES), R. THAXTER, PH. D. (pp. 161–165).—A reprint of Bulletin No. 107 of the station (see Experiment Station Record, vol. II, p. 711).

FUNGUS IN VIOLET ROOTS, R. THAXTER, PH. D. (pp. 166, 167).—Examinations of the roots of diseased violet plants revealed the presence of great numbers of dark spots "commonly involving the whole substance of the root for a distance of a few millimeters."

Sections of such spots show the tissue more or less blackened and destroyed, and lying in the cells in greater or less numbers, certain peculiar looking, squarish brown bodies, sometimes filling the cells completely and looking not unlike some form of smut. These squarish bodies are the result of the breaking up of large cylindrical 2–5 (or more) septate brown spores formed from a rather scanty septate mycelium, which apparently causes the death of the root cells at the affected points.

The fungus is undoubtedly the form described by Zopf (*Sitz. d. Bot. Ver. d. Prov. Brandenb., June, 1876, p. 105*) under the name *Thielavia basicola*, figured in Winter's *Pilze*, vol. II, p. 44, and also described and figured by Sorokin as *Helminthosporium fragile* (*Clasterosporium fragile*, Sacc.) in *Hedwigia*, 1876, p. 113, where the characteristic breaking up of the spores into squarish segments is well represented. According to Zopf, the fungus is the same as the form described by Berkeley and Broome (*Ann. and Mag. of Nat. History*, ser. II, vol. V, No. 465, plate 11, fig. 4) as *Torula basicola*, yet for reasons not mentioned all these are kept distinct by Saccardo.

Zopf describes an ascosporic condition on which the genus *Thielavia* is founded, which has not been observed by the writer except as a parasite on other fungi (species of *Isaria*), and states that a very serious disease of the roots of *Senecio* is due to its action.

As regards the disease of violets, however, it seems doubtful whether the observed injury done by the *Thielavia* would alone account for the condition of the plants, yet the mere presence of a form supposed to cause serious disease in the roots of other plants seems of sufficient interest to warrant the present note.

PRELIMINARY REPORT ON THE SO-CALLED "POLE BURN" OF TOBACCO, W. C. STURGIS, PH. D. (pp. 168–184).—An account of the origin of this disease and a discussion of methods for its prevention. "Pole burn" is prevalent in Connecticut and other tobacco-growing States, the severity of the disease varying in different years.

As the disease was first brought to the notice of the writer it was seen to be characterized by the appearance on the surface of the leaf of small blackened areas, giving the leaf the aspect of having been sprinkled with sulphuric acid or some other corrosive liquid. At first the disease is limited to the neighborhood of the veins and midrib of the leaf, where moisture is superabundant, but its spread is very rapid, the small blackened areas increase in size, become confluent, and sometimes within 36 or at most 48 hours not only is the whole leaf affected, but the entire contents of the curing barn may be rendered quite worthless as tobacco. Examination shows that the leaves have changed from greenish yellow to a dark brown or almost black color, that the fine texture has disappeared, and that instead of being tough and elastic the whole leaf is wet and soggy, and tears almost with a touch, falling of its own weight from the stalk.

[Specimens of diseased leaves sent to the station in the fall of 1891 were subjected to a thorough microscopic examination.]

On the less damaged leaves the appearance was as described above, but a small hand lens revealed in the center of each blackened spot a minute elevated pustule. Sections through the center of one of these pustules showed that the tissue of the leaf was largely disintegrated, and the cells themselves were completely filled with

bacteria, which, as they issued from the cells in vast numbers, gave a milky appearance to the water in which the section was lying. This being presumably the incipient stage of the disease, it was only necessary in order to trace its development, to select a series of leaves showing more and more advanced stages of decay and to examine the pustules successively. This method showed that the bacteria develop rapidly in the tissue of the leaf, raising the epidermis, and finally breaking through at one or more points in the blackened area. Oozing through the ruptured tissue, they spread out in a thin, slimy film over the surface in the immediate neighborhood of the pustule, finally forming a brown translucent crust of a cheesy consistency and composed entirely of the bacteria themselves. * * *

Examination with the microscope showed that there were invariably two forms of bacteria present, and only two—one in the shape of minute rods very rarely connected in chains, and belonging therefore to the genus Bacterium, the other consisting of spherical cells often united in chains and belonging to the genus Micrococcus. * * * The dimensions of these two forms are, Bacterium 1.9μ–$3.7\mu \times 0.8\mu$, Micrococcus spherical, 0.9μ–1.1μ in diameter. * * * It must be noted that two forms of bacteria very similar to those described—a bacterium and a micrococcus—always accompany and are taken to be the active agents in putrefaction whether of vegetable or animal substances, and the question naturally arises whether we have here merely a process of fermentation and putrefaction (whatever we may mean by these terms) common to all putrescible substances, and induced by the previous growth of some fungus on the diseased spot, or whether we have to do with specific agents of disease peculiar to tobacco. In this connection it is well to note that a German investigator, E. Suchsland, has recently discovered living organisms belonging to the Bacteria and Cocci groups, associated with the process of fermentation of all kinds of tobacco [see Experiment Station Record, vol. III, p. 354]. A fungus related to one of the common leaf diseases of the tomato, of the genus Cladosporium, does not occur in spots on tobacco leaves. Leaves partially cured, that is leaves taken at the period when the "pole burn" usually makes its appearance, but free from any developed fungus and bacterial disease, were kept in a damp atmosphere for some days. Under these conditions they developed on the leaves in the course of a few days, small brown spots of a velvety appearance under the microscope, the Cladosporium mentioned above. This fungus caused no widespread damage to the leaf, being limited to the very small spots in which it first appeared. In the course of 6 weeks, however, examination showed that the fungus was decaying rapidly and that in its place vast numbers of bacteria were developing, identical with those found in the pole-burned leaves. The gross appearance of the decaying area was similar to that characteristic of "pole burn," though, owing to the fact that the leaves were by this time almost thoroughly cured, the spread of the decay was not so rapid. Finally, mingled with the bacteria in the pustules of leaves undoubtedly afflicted with "pole burn," there were often found the remains of a fungus identical with the Cladosporium above mentioned. We may therefore infer, although conclusive results can only follow further examination, that "pole burn" is due primarily to the growth of a fungus upon the leaf, which, by disintegrating and partially destroying the tissue of the leaf, gives access to a bacterial process of decay. * * *

It is a matter requiring only delicate manipulation to isolate the bacteria from the "pole-burned" leaves and to obtain pure cultures. These were made in test tubes on both solid and liquid media. The bacteria developed readily on potato agar with a slight percentage of tobacco ash or a trace of peptone on slices of sterilized potato, and in potato broth with a trace of peptone. The sterilized potato gave the best results and the cultures have been continued on that substance. Under these conditions the bacteria form on the surface of the potato round or elongated and irregular colonies, of a slimy consistency, varying in color from livid gray to deep orange, and producing in the potato a dark stain beneath and around the colonies. In liquid

media they develop not on the surface, but as a flocculent deposit in the liquid. Certain facts may now be noted and compared with facts ascertained in the curing of tobacco.

(1) As the cultures become dry the bacteria cease to develop so rapidly, and finally their development ceases. They require, therefore, moisture for growth, and decreasing the amount of moisture decreases their vitality. This bears out the general view that the origin and spread of "pole burn" is in some way connected with an excess of moisture in the curing barn.

(2) Nine tubes, each containing a slice of sterilized potato, were inoculated with the bacteria. Of these, three were kept at a temperature of 100° F., three at a temperature of 70° F., and the remaining three at a temperature of about 40° F. At the end of 3 days the tubes kept at 70° showed the usual growth, the colonies averaging 1.5 inches in length by 0.5 inch in breadth. Neither of the other sets of tubes showed any marked growth, but upon being placed at the medium temperature for 48 hours the development of the bacteria proceeded with marked activity. These experiments were repeated at various degrees of temperature. Temperature, therefore, has a marked influence upon these germs. Warmth up to 70° and even 90° is favorable to their development, whereas temperatures above 100° or 110° and below 35° to 40° act as a temporary or permanent check upon their vitality. To this fact again we find a corresponding theory, that warmth as well as moisture is conducive to "pole burn." Inasmuch as in this regard bacteria as a rule follow the laws governing the active growth of the higher fungi, it is immaterial at present to decide whether the former or the latter are the primary cause of "pole burn," since the means which may be recommended to prevent the decay apply equally well to arresting or preventing the growth of the Cladosporium.

(3) One more fact should be stated, viz, that all attempts to inoculate thoroughly cured tobacco with the bacteria failed. This result is at least a partial confirmation of the generally expressed view that when tobacco has cured to a certain degree, the period varying from 10 days to 3 weeks after hanging, there is very little danger to be apprehended from "pole burn."

The means for the prevention of "pole burn" and the conditions necessary to the proper curing of tobacco are discussed. A tobacco barn should be weather-proof and so ventilated that a free circulation of air can be secured when desired. Attention is called to the fact that the curing of tobacco is not so much a process of drying as of fermentation, and that it is therefore desirable to establish conditions which will promote those chemical changes which produce the best quality of cured tobacco. The advantages and disadvantages of curing the leaves on the stalk and of detaching the leaves from the stalk before hanging are stated, without a decision in favor of either method. The method for the employment of artificial heat in curing tobacco, recommended in the Report on Tobacco in the Tenth Census of the United States, vol. III, by J. B. Killebrew, is described and the merits of the use of artificial heat for this purpose are discussed. "To aid the process of fermentation when other conditions are unfavorable and to establish within the barn at critical periods conditions which shall prevent the occurrence of 'pole-burn,' are the only uses for artificial heat in this connection."

Stem rot of tobacco, W. C. Sturgis, Ph. D. (pp. 184–186).—A popular description is given of *Botrytis longibrachiata*, the fungus causing the stem rot which often injures tobacco in the later stages of curing. The thorough cleansing of the curing barn and the destruction of

all refuse are the best and simplest precautions. Fumigation with sulphur is recommended as an effectual method of destroying the spores.

THE CURING OF HAVANA SEED LEAF TOBACCO BY ARTIFICIAL HEAT (pp. 187–196).—The so-called "Snow modern barn system" of curing tobacco was introduced into Connecticut in 1891, and the station was requested to make observations on this method of curing. The barn and apparatus used in this system are briefly described. An experimental barn was erected at Suffield, Connecticut, in which Havana seed leaf tobacco grown in that town was cured by Mr. E. F. Paschal. "So far as known the system had not been applied before to the curing of wrapper tobacco"

A. L. Winton, jr., Ph. B., of the station and an assistant made observations of the temperature and relative humidity in the barn during the curing process, which are reported in detail in a table. The time required for filling the barn and curing the leaves was just 11 days, probably a longer period than would ordinarily be taken. Filling the barn occupied 12 hours, wilting the leaves 18 hours. The following is a summary of the observations arbitrarily divided into different periods:

Our observations began when the barn was closed and the fires built—August 22, at 1 p. m.

(1) From the time the fires were fairly going and the flues warmed till the yellow color appeared on the tips and in spots over the leaf—39 hours—the temperature of the barn fluctuated between 91° and 105° F., and on the average was 97°. The relative humidity in the barn was from 86 to 100, and on the average was 92, while that of the outer air averaged 82. This is a nearly saturated atmosphere, and while a good deal of water in the aggregate might evaporate from leaves four fifths of the weight of which was water when they were put in, there is nothing like rapid drying.

(2) From the time when yellow patches first appeared to the first signs of browning—24 hours—the temperature of the barn varied between 98° and 105°, and on the average was 102°. The relative humidity varied between 78 and 90, or on the average 83, while that of the outer air varied from 77 to 94, and averaged 86. In this period the temperature has risen 5° and the humidity has fallen slightly, the leaves are "sweating," and water stands on them in drops. Here again there is no doubt slow drying, but nothing like what would take place in even moderately dry air. The atmosphere of the barn is at this time almost insupportable because of the moisture.

(3) In the following 24 hours the same state of things continues. Temperature between 96° and 101°, averaging 99°; relative humidity 74 to 81, averaging 77. At the end of this period note was first made of a "tobacco odor," difficult to describe but due to an exhalation that was intensely irritating to the eyes and considerably so to the throat. Analyses of the leaves before and after curing do not indicate any considerable loss of nicotine.

(4) Next follows a longer period—54 hours—during which the tobacco odor is very strong, at times almost unbearable even for the time needed to make observations. In this period the leaves are drying somewhat more rapidly, though entirely limp and damp to the touch, and the curer is waiting for the brown color to spread over the whole leaf and to become dark enough. Temperature from 99° to 109°, averaging 105°; humidity from 62 to 80, averaging 70.

(5) Next is a short period—18 hours—during which the air grows rapidly drier. This period might probably have been omitted and the heat raised at 2 p. m on the twenty-eighth, but for greater security the curer waited.

(6) In the last period of the cure the heat was run up to 157° simply to cure and dry out the midribs perfectly. When this was done it was only necessary to cool and dampen the leaves so they could be handled.

There are also brief notes on successful experiments in curing upper leaves and stem suckers.

Georgia Station, Bulletin No. 16½, March 1, 1892 (p. 1).

This is a notice regarding the bulletins of the station, to be posted in post offices of the State.

Illinois Station, Bulletin No. 18, November, 1891 (pp. 16).

DAIRYING EXPERIMENTS, E. H. FARRINGTON, M. S. (pp. 17–32, fig. 1).—The work reported under this heading includes tests of cows at the Illinois State Fair and at the American Dairy Show at Chicago, a comparison of the Babcock milk test with the churn, devices used in milk testing, tests of composite milk samples, tests of methods of cream separation, and cream raising by dilution.

Milk tests at fairs (pp. 18–21).—At the State fair at Peoria in 1891, tests were made on 1 day (September 29) of the milk of 6 Ayrshire, 7 Holstein, 13 Jersey, and 2 Shorthorn cows, divided into two classes, those over and those under 3 years of age. The results of these tests and the calculated yield of butter fat per day and per 100 pounds live weight are tabulated. The prizes were awarded to the cows producing the most butter fat on the day the test was made. Of the younger cows the largest yield of butter fat (1.37 pounds) was by a Holstein, and the next largest (1.04 pounds) by a Jersey. Of the older cows the two highest yields of butter fat (2.23 and 1.73 pounds) were by Holstein cows. The 3 older Holsteins gave the highest average yield of butter fat (1.55 pounds) and the 8 older Jerseys the next highest (1.28 pounds). "No very striking variation in the composition of the milk given by any one cow at different milkings is shown. Some cows gave the richest milk at night, some in the morning. Generally the cows which were milked three times each day gave the richest milk at noon."

At the American Dairy Show three cows, 2 Brown Swiss and 1 Devon, were tested for 3 successive days. The detailed results of these tests show that in the 3 days one of the Brown Swiss cows, 11 years old and weighing 1,395 pounds, produced 245 pounds of milk containing 9.32 pounds of butter, or an average daily production of 81.7 pounds of milk and butter fat equivalent to 3.95 pounds of butter with 80 per cent fat. The other Swiss cow averaged per day 65.08 pounds of milk and 2.74 pounds of butter with 80 per cent fat.

Comparison of the Babcock test with the churn (pp. 22–25).—Two comparisons were made at the American Dairy Show, the milk being creamed by a separator in both cases. In the first test 52 pounds of milk was taken, which contained, according to the Babcock test, 1.971 pounds of butter fat; the churn yielded 2.1875 pounds of salted butter, or about

3 ounces more than the test indicated. In the second test 2,035.25 pounds of mixed milk was taken, containing by test 84.46 pounds of butter fat; the yield of salted butter was 104.5 pounds, or 20.04 pounds more than the test indicated. The analyses of the butter showed that in the first case there was a loss by handling of 9.7 per cent of the butter fat, and in the second a gain of 2.17 per cent, believed to be due to the absorption of water by the boxes in which the butter was packed.

Five comparisons were made at the station, the cream being raised in Cooley cans or in shallow pans. The results are tabulated, together with analyses of the butter. Less than 2 pounds of butter was secured in any trial. The difference between the amount of butter fat indicated by the Babcock test and the salted butter obtained ranged from -0.027 to $+0.308$ pounds.

Automatic pipette (p. 26).—This is for measuring the acid used in the Babcock milk test. The pipette holding 17.5 c. c., with a bulb at the upper extremity to catch the overflow, is connected by a glass tube with the reservoir bottle on the desk and is closed at the bottom by a two-way cock. The acid is forced into the pipette by means of rubber blowing bulbs. The cock is then turned, allowing the acid to run into the test bottle. The advantage claimed is that the acid bottle "is kept closed, thus preventing any change in the strength of the acid."

Marking test bottles (pp. 26, 27).—It is suggested to roughen a small surface on the bottle with a wet file and then write the label on with a pencil.

Composite milk samples tested for butter fat (pp. 27, 28).—A report of the testing of milk at a creamery at De Kalb by means of composite samples preserved with "powdered lye."

Test of methods of cream separation (pp. 28–30).—A number of trials are reported which were made to test the thoroughness of creaming when milk was set in Cooley cans at between 45° and 48° F., and skimmed after 12, 24, 36, and 48 hours, respectively. Tests were made of the skim milk from the bottom and middle of the can, and that drawn off last.

An average of 2.4 per cent of the total butter fat in the new milk was lost in the skim milk when skimmed after 48 hours' standing, 4.05 per cent after 36 hours, 3.7 after 24 hours, and 12.87 after 12 hours. * * *

Drawing off the skim milk to within 1 inch of the bottom of the cream can be done without loss of cream, if the faucet is set so that the skim milk does not stop running until it has reached the point where you wish it to stop; repeated opening and closing of the faucet has a tendency to mix the cream so that it flows out with the skim milk.

Where milk was set in shallow pans and skimmed after 12 and after 24 hours the loss of fat in the skim milk was 5.18 and 1.62 per cent, respectively. "More uniformly complete separations of cream than any of the above can be obtained by using a Baby hand separator, which we have repeatedly tested, obtaining skim milk with less than 0.1 per cent butter fat."

In comparisons of setting milk 3, 6, and 9 inches deep at about 70° F., "the cream rose faster and more completely in the shallow pans 3 inches deep than when set in bottles 6 or 9 inches deep."

Cream raising by dilution (pp. 30–32).—These trials were made in wide-mouthed bottles with an outlet at the bottom for drawing off the skim milk. The milk of different cows was diluted with an equal volume of water at about 58° F. and kept in a room where the temperature ranged from 66°–76° F. About half a pint of milk was taken for each trial. The skim milk was tested after the mixtures had stood 1, 2, 6, and 9 hours. The results are tabulated. "The average of all the results obtained showed that in this trial there was left in the skim milk about 40 per cent of the total butter fat after standing 1 hour, 30 per cent after 2 hours, 17 per cent after 6 hours, and 14 per cent after 9 hours."

Similar trials, made with undiluted milk which was cooled in a refrigerator to about 75° F. and then kept at 70°–75° F., showed less uniformity in the thoroughness of the creaming of the milk of different cows.

With rich milk and with that from a new milch cow the cream rose as completely when the new milk was quickly cooled to 70° F. without the addition of water as it did when diluted with an equal quantity of water. The rising of the cream was more complete in a given time and was hastened by diluting the milk from cows that were not fresh or that gave a considerable quantity of average milk.

Illinois Station, Bulletin No. 19, February, 1892 (pp. 16).

EXPERIMENTS WITH OATS, 1891, G. E. MORROW, M. A., AND F. D. GARDNER, B. S. (pp. 33–44).—The experiments were on rate and depth of seeding, and tests of varieties of oats. They were all made on the fertile dark-colored prairie soil of the station grounds. The season was unusually favorable for oats.

Oats, quantity of seed per acre (p. 35).—Welcome oats were sown on 7 plats, each 1 by 16 rods, at the rate of from 1 to 4 bushels per acre, and covered by harrowing twice with a slant-toothed harrow. The yields per acre of both grain and straw for each of the 4 years the experiment has been in progress and the averages of the 4 years, are tabulated for each rate of seeding.

The largest yield of grain [in 1891] was from sowing 3.5 bushels per acre, with little variation between the plats sown at the rate of 2, 2.5, 3, 3.5, and 4 bushels per acre. The average yield for 4 years was slightly larger when 3.5 bushels were sown, with comparatively little difference whether 2, 2.5, 3, 3.5, or 4 bushels were sown. For the 4 years' sowings, 1 or 1.5 bushels gave smaller average yields than any of the heavier seedings. The weight of the grain per bushel was less in the case of the light seeding. The yield of straw increased with the increase in rate of seeding. For the 2 preceding years the lightest seeding gave the largest yield of straw. For the 4 years there was comparatively little difference in the yield of straw.

Oats, depth of sowing (pp. 35, 36).—Welcome oats were sown in twelve 10-foot rows, being covered at depths ranging from 1 to 6 inches. Sparrows so interfered with the grain that the actual yield could not be ascertained, and only the number of panicles was counted for each

row; but the indications were that the returns were slightly better from covering 2 inches deep. "In trials for 4 years the best results have not come from covering the same depth in any 2 series."

Oats, test of varieties (pp. 36–44).—The results of tests of 44 varieties of oats on 55 plats in 1890 and 1891 are tabulated and discussed.

The average yield per acre was 66.6 bushels of grain, weighing 33.5 pounds per bushel, and 2,840 pounds of straw. Four varieties gave more than 80 bushels per acre, and but one less than 50 bushels per acre. Nineteen varieties on 21 plats gave an average yield of 74.7 bushels, with averaging weight of 34.12 pounds per bushel. * * *

The early-maturing varieties are those harvested July 6 to 14; the medium, July 16 to 20; and the late, July 21 to 30, excepting Virginia Winter, which was harvested August 7, and being a winter variety, may be left out of the account. * * *

The early-maturing varieties are superior to either the medium or late in the average yield of both grain and straw, the weight per bushel, and size of berries, but are inferior to either of these in per cent of kernel. As to berries (short plump and long slender), there is very little difference in yield, a noticeable difference in weight per bushel in favor of the short plump, and a difference of 2.1 per cent in kernel in favor of the long slender.

The white berries gave the largest yield of grain and the smallest per cent of kernel; the dun-colored gave the smallest yield and the largest per cent of kernel.

As to panicles, open or closed, the latter is superior in yield of both grain and straw and also in per cent of kernel.

As to weight per bushel, those which weigh less than 32 pounds are superior in both yield and per cent of kernel. Notwithstanding the common belief to the contrary, those oats which weigh least to the bushel have usually the highest per cent of kernel, and consequently the highest food value. * * *

Thirty varieties have been tested for 3 years and 14 additional for 2 years. * * * No one variety has been shown to be greatly superior to all others. A different variety stood first in yield in each of the 3 years.

THE CHINCH BUG IN ILLINOIS, 1891–92, S. A. FORBES, PH. D. (pp. 44–48).—"The almost uniformly high temperature of the spring and summer of 1890 and 1891 in northern and in southern central Illinois, combined with light rainfall, amounting in some counties to little less than continuous drouth, favored unusually the development of the chinch bug in these sections, and if similar conditions should prevail for another season, serious loss can hardly fail to ensue, especially in the northern part of the State."

Brief abstracts of field notes and correspondence are given, showing the amount of injury to crops in different localities in the State. Measures to be used for the repression of the chinch bug are briefly stated. The author is making experiments with contagious insect diseases, and will supply material for infection to those who desire to try this method of combating the chinch bug.

Indiana Station, Bulletin No. 38, March, 1892 (pp. 29).

EXPERIMENTS WITH SMALL FRUITS AND VEGETABLES, AND DISEASES OF GRAPES, J. TROOP, M. S. (plate 1).—A report of tests of varieties of strawberries, raspberries, blackberries, currants, gooseberries, beans, peas, sweet corn, and potatoes; experiments with fertilizers and

different methods of culture on potatoes; and experiments in the treatment of powdery mildew and black rot of grapes. The experiments with small fruits were carried on at the station and at four substations in different parts of the State.

Strawberries (pp. 6–12).—Tabulated data for 63 varieties, 44 of which are briefly described. The 10 most productive ones were Bubach, Edgar Queen, Enhance, Greenville, Haverland, Katie, Park Beauty, Pearl, Shuster Gem, and Warfield. The 10 of best quality were Brunette, Cumberland, Eureka, Gypsy, Henderson, Katie, Lovett Early, Miami, Pearl, and Sharpless.

Raspberries (pp. 12–14).—Tabulated data and descriptive notes on 10 red and 13 black varieties. Cuthbert, Brandywine, Acme, and Hilborn are especially commended.

Blackberries (p. 15).—Tabulated notes on 14 varieties. Erie, Minnewaski, Snyder, Taylor, and Stone Hardy are especially commended.

Diseases of grapes (pp. 17, 18).—Powdery mildew on greenhouse grapes was largely prevented by spraying with potassium sulphide, 1 ounce to 5 gallons of water. Black rot of grapes was prevented by spraying with Bordeaux mixture.

Wax beans (pp. 18, 19).—Tabulated data for 28 varieties. For family use, Algerian, Challenge, Golden, Golden-Eyed, Refugee, and Yosemite Mammoth are recommended.

Peas (p. 20).—Tabulated data for 24 varieties. "American Wonder, Dan O'Rourke, Earliest of All, Ferry Best, Kentish Invicta, Laxton Alpha, and Little Gem were ready for market in 58 days from the time of planting."

Sweet corn (pp. 20, 21).—Tabulated data for 37 varieties. The following are recommended: Cory, Chicago Market, Concord, Crosby, Henderson, Orange, Hickox, Maule Evergreen, Ne Plus Ultra, and Stowell Evergreen.

Potatoes (pp. 22–29).—The yields and the time of planting are tabulated for 84 varieties for the years 1889–91. The most productive varieties were Governor Rusk and Alexander. A brief account is given of a test of the keeping qualities of the different varieties. Boneblack, nitrate of soda, and sulphate of potash, two by two and all three together, were applied on land which had borne three successive crops of sweet corn and potatoes without receiving any fertilizer. Stable manure and unleached ashes were also used on separate plats. The results indicate that both potash and phosphoric acid were needed, but that the addition of nitrogen made no material difference in the yield.

An experiment in planting whole and half tubers, with different methods of culture, is briefly reported. The results were as follows: "(1) Subsoiling gave a very small increase in yield over ordinary plowing; (2) the mulch was injurious rather than beneficial; (3) ridge culture gave a small increase over level; (4) half tubers produced a larger yield than whole ones; (5) seed ends gave a much larger proportion of

large tubers; (6) trenches filled half full at the time of planting gave a larger yield than those filled full."

Iowa Station, Bulletin No. 15, November, 1891 (pp. 96).

SUGAR BEET GROWING, J. WILSON, C. F. CURTISS, B. S. A., D. A. KENT, B. S., AND G. E. PATRICK, M. S. (pp. 199–205).—In 1891 sugar beets were grown at the station on "comparatively new" loam soils, both with and without fertilizers and with subsoiling. Lime, a "complete fertilizer," and ammoniated superphosphate were used in amounts not stated. Beets were planted at different dates from April 15 to May 25. The varieties treated were Klein Wanzleben, Vilmorin, and Desprez. Samples of the beets were taken for analysis September 30, October 12, and November 6. The yield and composition of the beets are tabulated. Beets were produced with as high as 15.7 per cent of sugar, giving juice of 82.5 purity, and 5 samples contained over 14 per cent of sugar.

(1) Early planting gave the greatest tonnage and most sugar per acre.

(2) Very large beets did not sugar well.

(3) Subsoiling gave the best shaped beets and the highest per cent of sugar in November, needing the least trimming.

(4) Cutworms destroyed most of the early plantings, but did not affect the later plantings.

(5) Per cent of sugar was affected by second growth in October or by absorbing moisture from rains after long drouth, or both.

(6) Yield per acre has much to do with the profitableness of the crop.

(7) While our highest analysis came from beets averaging 13 ounces trimmed and yielding 12.32 tons per acre, our largest yield of sugar per acre came from beets averaging 21 ounces trimmed and yielding 28.16 tons per acre.

(8) Clay soil gave us the highest per cent of sugar and comparatively higher purity, and the lowest tonnage per acre.

(9) The plats fertilized with lime, nitrogen, phosphoric acid, and potash showed no benefit.

(10) The average per cent of sugar was 14.14 and the average yield about 20 tons per acre, and the cost of growing and harvesting $39.42 per acre. The highest sugar in beets per acre was 7,299 pounds.

SUGAR BEETS IN IOWA, 1891, G. E. PATRICK, M. S., E. N. EATON, B. S., AND D. B. BISBEE, B. S. (pp. 206–233).—This is a report on the analysis of 502 samples of sugar beets grown in 49 counties of the State.

The proposition made in Bulletin No. 12 of the station [see Experiment Station Record, vol. II, p. 718] for an extensive investigation of the possibilities of sugar beet culture in this State, to be made jointly by the farmers of the State and the chemical section of the station, has resulted in the work reported in this article.

The results here recorded are almost wholly those obtained in the laboratory. The information furnished by the growers regarding the character of the soil in which the beets were grown and its treatment before planting and during growth of the crop, must be brought into condensed form before it can be of much value to the public, and as it will take considerable time to do this that portion of our report is reserved for a future bulletin. * * *

The results are arranged by counties, commencing with the northernmost tier and proceeding by tiers southward.

The exhibit plainly shows that in a season like that of 1891 beets of good quality for sugar production can be grown in certain parts of Iowa. * * *

It is not safe to assume that the relative adaptability of the different counties to the beet sugar industry is truly or even approximately represented by the results of a single year's investigation, and this is of course especially true of those counties from which but few samples were received.

It is true the results for the State as a whole do not indicate as high an average quality of beet as is reported from some States in the drier regions farther west and northwest; but on the other hand the average yield of beets per acre is in Iowa very much larger than is possible in those States without irrigation.

FUNGOUS DISEASES OF SUGAR BEETS, L. H. PAMMEL, B. AGR. (pp. 234–254, plates 7).—Illustrated notes on beet rust (*Uromyces betæ*), white rust of beets (*Cystopus blitii*), spot disease of beets (*Cercospora beticola*), a root disease of beets (probably related to *Rhizoctonia betæ*), and the scab of beets.

The white rust was observed on the leaves of beets at the station in the fall of 1890. It formed white pustules on both sides of the leaf, which consisted of a large number of small spores. The germination of the conidia was not observed, nor were any of the oöspores found. The author, however, thinks that the fungus in all probability is *Cystopus blitii*.

The spot disease of beets was quite prevalent on sugar beets at the station. Analyses indicated that this disease did not materially affect the sugar content of individual beets, though it reduced the total yield of the crop. The author has observed that the conidiophores of this fungus "not only pass out through the stomata, but also break the epidermal cells." He thinks that Bordeaux mixture and ammoniacal carbonate of copper may be used as preventives, but has made no experiments in this line.

A root rot disease of sugar beets was observed at the station in August, 1891. "It did not appear to be the nematode disease common in Europe, though nematode worms (allied to *Anguilula*) were common in the decaying roots." The author thinks it is caused by *Rhizoctonia betæ*, described by Kühn. The disease manifests itself by a gradual dying of the plant, the leaves usually turning pale and becoming limp. Holes closely infested with the brown mycelium of the fungus are found in the crown or sides of the beets. The mycelium slowly extends down the root and usually invades all the smaller roots and rootlets. Bacteria play a part in the ultimate rotting of the beet. Several species have been isolated. The disease was induced in healthy beets by inoculation. Rotation of crops is suggested as a preventive.

Scab on beets has been observed by the author in a few cases, and he is inclined to believe that it is identical with the deep form of potato scab.

NOTES ON INJURIOUS INSECTS, H. OSBORN, M. S., AND H. A. GOSSARD, B. S. (pp. 255–273, figs. 3).—Notes on the Indian cetonia (*Euphoria*

inda), clover leaf hopper (*Agallia sanguinolenta*), clover seed caterpillar (*Grapholitha interstinctana*), clover drasteria (*Drasteria erechtea*), clover hay worm (*Asopia costalis*), and the following insect enemies of the sugar beet: Cutworms, grasshoppers, blister beetles, wavy striped flea beetle (*Phyllotreta vittata*), triangle flea beetle (*Disonycha triangularis*), *Phyllotreta albionica*, wireworms, gray plant bug (*Piesma cinerea*), tarnished plant bug (*Lygus pratensis*), false chinch bug (*Nysius angustatus*), purslane bug (*Geocoris bullata*), and some insects associated with rotting in beets (*Homalomyia* sp., mites of the order *Acarina*, etc.).

It having been reported to the station that an insect which was probably *Euphoria inda* was eating into ears of corn at Coon Rapids, Iowa, experiments were made by the author to determine whether the beetles of this species when confined upon ears of corn would eat into them. It was found that "this beetle has the power of entering, unassisted, the husks of corn ears, either by burrowing through the silk or by pushing aside the husks, and that they will thus enter the ears if forced to do so to obtain food."

"The clover leaf hopper (*Agallia sanguinolenta*) has been traced through its transformations and found to develop fully on a diet of clover, and it is probable that this is its more common food, but that it also attacks grass, beets, various weeds, and other plants, according to abundance or season. For treatment the hopper-dozer plan is recommended in grass and clover, and kerosene emulsion on beets."

The third brood of adults of *Grapholitha interstinctana* appeared before September 8, and the third brood of caterpillars was observed September 19. Some adults of this latter brood appeared October 9.

The grasshoppers which most numerously attacked beets were *Melanoplus femur-rubrum*, *Caloptenus differentialis*, *Chlœaltis curtipennis*, and perhaps *Acridium emarginatum*. Reference is made to previous notes on these insects in Bulletin No. 14 of the station (see Experiment Station Record, vol. III, p. 222).

Soiling experiment, J. Wilson, C. F. Curtiss, B. S. A., D. A. Kent, B. S., and G. E. Patrick, M. S. (pp. 274–283).—This was with six Shorthorn cows and lasted from June 20 to September 26. The object was to compare stall feeding on green fodders with good blue grass pasturage. During the first half of the experiment lot 1 (three cows) was barn fed and lot 2 was pastured, and during the last half this was reversed. At all times each cow received grain consisting of either 12 pounds of corn-and-cob meal, 10 pounds of gluten meal, or 18 pounds new whole corn. The pasture was one of the best blue grass pastures in the State, well shaded with occasional trees and in places by dense woods, with running water accessible. The soiling consisted at different times of green oats and peas, oats and clover, or fodder corn and clover, fed *ad libitum*. Frequent analyses were made of the milk of the individual cows, and these, together with the milk yielded, are tabulated.

Owing to the period of lactation, lot 1 increased in milk while in the stable and lost very fast as soon as they were put in the pasture. Lot 2 had lost heavily on pasturage and gained in milk as soon as they were put on green feed. * * *

The indications from this experiment are:

(1) The average cow, when kept in the stable, will eat about 75 pounds of green feed a day, with grain ration added.

(2) Cows fed on oats and peas or clover and corn, fed green in the stable in midsummer, will give more milk than when feeding on a good blue grass pasture.

(3) A cow fed on green feed in a stable darkened and ventilated will gain in weight more than she will in a well-shaded pasture.

(4) The cow responds as promptly to a well-balanced ration of grain while eating green feed as she does on dry feed.

The yields per acre are given of green fodder from peas, peas and oats, fodder corn, and second-cut clover

Time of sowing grass seed, J. Wilson, C. F. Curtiss, B. S. A., and D. A. Kent, B. S. (pp. 284–288).—"For the purpose of ascertaining the best time to sow the seed of cultivated grasses, this station sowed the seed of six different grasses at eight different times, beginning March 23 and ending May 12, 1891. The varieties sown were red clover, white clover, timothy, orchard grass, tall meadow oat grass, and awnless brome grass (*Bromus inermis*). The plats were 1 rod square. The soil was rolling prairie with black surface and clay subsoil, fall-plowed." The best results in every case were from the earliest sowing.

"Late-sown red clover maintained a stand better than any other late sowing. The May sowings of all varieties were failures. Late-sown varieties that looked well at time of cutting did not endure the subsequent drouth. The first-sown grasses were best in October."

Test of varieties of winter wheat and oats, J. Wilson, C. F. Curtiss, B. S. A., and D. A. Kent, B. S. (pp. 289–294).—Notes and tabulated data for 14 varieties of winter wheat and 11 of oats. Turkish Red and Jones White Fife wheat, and Early Everitt and Giant side oats gave especially good results.

Barnyard manure, J. Wilson (pp. 295, 296).—A brief account of an experiment with liquid barnyard manure on corn. The plants made a vigorous growth and the yield was materially increased.

Iowa Station, Bulletin No. 16, February, 1892 (pp. 72).

Flaxseed meal and oil meal, J. Wilson, C. F. Curtiss, B. S. A., and D. A. Kent, B. S. (pp. 299–302).—A trial was made with 10 cows to ascertain how much ground flaxseed and how much linseed meal could be fed without noticeable injury to the animals. The cows were divided into 2 lots, one lot receiving ground flaxseed and the other linseed meal. Both lots received cut corn fodder *ad libitum* and small amounts of corn meal. The trial lasted from December 1, 1891, to January 20, 1892, during which time the ground flaxseed and linseed meal were both increased at the same rate to from 1 pound to 8 pounds per animal daily. From January 8 to 20 the cows in each

lot received 8 pounds each daily of the ground flaxseed or linseed meal. When this point was reached the flaxseed lot refused to eat more, but the linseed meal lot it is believed would have consumed still more had it been offered. One cow in the flaxseed lot was a poor feeder and did not eat her share of any ration, and lost weight during the trial. The weights of the animals in each lot at different times during the trial are tabulated, each weighing being the average of three separate weighings.

The indications from feeding ground flax and oil meal are:

(1) Mature cows will eat 8 pounds a day of either without bad effects of any kind if they are gradually increased to that amount.

(2) There was little difference in increased weight from feeding flaxseed and oil meal, with 12 pounds of corn meal and all the corn fodder the cows would eat each day.

(3) Feeding flaxseed meal and oil meal heavily to pregnant cows had no injurious effects in this case.

Crop report of the farm department, D. A. Kent, B. S. (pp. 303–308).—In this are included reports on two fields of corn, a small field of barley, and the storing of silage in three silos.

Cornfield No. 1 contained 21.25 acres of rich sandy loam. It was sown to Early Mastodon corn planted in hills. The climatic conditions were rather unfavorable to the growth of corn, and owing to the small rainfall, the roller, harrow, and cultivator were used to conserve the moisture and heat. The yield was 75 bushels of corn per acre, or 1,598 bushels in all. The statement of the cost of labor in raising the crop shows this to have been $146.82, or 9.22 cents per bushel of corn.

Cornfield No. 2 contained 14.5 acres of sandy loam land. It was planted to Improved Leaming corn, which was cultivated in the same way as that on field No. 1. The yield of corn on this field was 86.5 bushels per acre, making a total of 1,258.5 bushels. The total cost of labor was $90.92, or 7.22 cents per bushel of corn, which is 2 cents per bushel less than the rate of field No. 1. "By intense cultivation and proper rotation, most of the farms of Iowa would produce from 75 to 80 bushels of corn per acre, and under favorable climatic conditions still more."

The size of the barley field is not given. The soil was a sandy loam and was sown to Mansbury barley. The cost of labor per bushel of barley is estimated at 11.2 cents.

Three silos were filled with corn fodder, the first from Early Leaming, the second from Mammoth Cuban, and the third from Red Cob Ensilage corn. The first silo was covered with chaff about 1 foot deep, but not weighted; the second had no chaff or weighting, and the third was weighted with about 3 tons of stone. The cost of filling the first silo is estimated at 79.5 cents per ton, the second at 71.4 per ton, and for the third silo is not given. The silage from all three silos is said to have been good.

Varieties of potatoes, C. F. Curtiss, B. S. A. (pp. 309–311).—Tabulated notes for 30 varieties. "Of the early varieties, the Early

Ohio and Everitt Six Weeks did the best; the latter is the earlier, but does not yield as good a potato as the former. The Early King is also promising, but ripened a little later. Of the late varieties, Rural New Yorker No. 2 was the finest potato we had. The Bus Barn and Green Mountain yielded better, but the potatoes were not as good. The Rogers Seedling is very large and nice, and the Mrs. Foraker ranks among the best."

Corn growing, C. F. Curtiss, B. S. A. (pp. 312–314).—Corn of the Capital variety was grown on 5 acres of land manured with 163 loads of barnyard manure and on 1 acre adjoining this piece without manure. In preparing both of these pieces of land in the spring a crop of winter rye was plowed under. Both fields were cultivated exactly the same during the entire season. The unmanured acre yielded 40.9 bushels of corn and the manured land 59.2 bushels per acre. Early Mastodon and Mammoth Cuban corn grown on fall-plowed land without manure yielded 71.2 and 82.5 bushels of corn per acre, respectively. The large yield of these 2 varieties on unmanured ground is believed to be partly due to early planting, as a drouth set in in May.

Experiments with fungicides, L. H. Pammel, B. Agr. (pp. 315–329, figs. 3).—An account of experiments on corn smut and wheat rust, and with reference to the injury to the roots of corn plants by copper salts.

Experiments on corn smut (pp. 315–321).—Notes and tabulated data on field experiments in which corn was grown from seed treated with hot water, ammoniacal carbonate of copper, or copper sulphate, and from untreated seed. The results from hot water treatment were favorable. With ammoniacal carbonate of copper they favored the treatment, but in the case of copper sulphate the treatment seemed to increase the smut. On 1 plat corn was grown from seed which had been rolled in tar and placed over an open water bath. A very poor stand was obtained from this seed and the development of smut was not prevented. Calculations are given with reference to the relative amount of smut on different parts of the corn plant. The stalks were smutted more than the ears, and the largest amount of smut appeared on the lower part of the stalk.

Effect of copper on the roots of corn (pp. 321–324).—An account is given of an experiment in a greenhouse in which Capital corn was treated with ammoniacal carbonate of copper, Bordeaux mixture, eau celeste, modified eau celeste, or ferrous sulphate. "Before planting, the soil was thoroughly pulverized, and to each lot of the whole series there was added 500 c. c. of the fungicide, evenly distributed and mixed with the soil. It was planted with corn the following day."

When ammoniacal carbonate of copper was used the roots were considerably injured. The other fungicides produced little if any effect.

Experiments on wheat rust (pp. 324–329).—Two forms of wheat rust (*Puccinia graminis* and *P. rubigo-vera*) are described and illustrated,

and brief accounts are given of unsuccessful experiments with ammoniacal carbonate of copper and Bordeaux mixture.

LICE AFFECTING DOMESTIC ANIMALS, H. OSBORN, M. S. (pp. 330–353, plates 2, fig. 1).—Illustrated descriptions of some 15 species, taken from the author's article in Bulletin No. 7 of the Division of Entomology of this Department (see Experiment Station Record, vol. II, p. 609).

SUGAR BEETS, G. E. PATRICK, M. S. (pp. 354, 355).—Brief directions regarding the culture of sugar beets, published with a view to stimulating the production of beets in Iowa this year.

TREES, SHRUBS, AND SMALL FRUITS FOR THE HOME GROUNDS, J. L. BUDD, M. H. (pp. 356–365).—As a result of experiments at the Iowa Agricultural College and elsewhere in the State, the author recommends the following species and varieties for planting in the northern part of the State: *Shade trees.*—Hard maple (*Acer nigrum*), hackberry (*Celtis occidentalis*), basswood (*Tilia americana*), white elm (*Ulmus americana*), cut-leaved birch (*Betula amurensis*), white pine (*Pinus strobus*), red pine (*Pinus resinosa*). *Ornamental trees.*—Wild olive (*Elæagnus angustifolia*), American mountain ash (*Sorbus americana*), rosemary willow (*Salix rosmariæfolia*), white Siberian almond, *Prunus triloba*, amur chokecherry (*Prunus maacki*), weeping bird cherry (*Prunus padus*), tree lilacs, tree snowball, tree berberry (*Berberis amurensis*), Russian privet, pea tree (*Caragana arborescens*), mountain pine (*Pinus pumilus*), silver spruce (*Picea pungens*), white spruce (*Picea alba*). *Shrubs.*—Hydrangea, tamarix, *Rosa rugosa*, mock orange, *Lonicera splendens*, *L. alberti*, *L. kylosteum*, climbing honeysuckle (*L. sempervirens*), *Spiræa vanhouteii*, *S. douglasi*, snowball, Virginia creeper (*Ampelopsis quinquefolia*). *Grapes.*—Moore Early, Cottage, Worden, and Concord. *Strawberries.*—Warfield, Haverland, Crescent, Beder Wood, Parker Earle, and Downer Prolific. *Raspberries, black.*—Older, Tyler, and Shaffer Colossal; *red*, Cuthbert. *Blackberries.*—Snyder and Ancient Briton. *Currants.*—White Grape, Victoria, and Black Naples. *Gooseberries.*—Houghton Seedling. *Dwarf juneberries.*—Osage.

HINTS FOR BEGINNERS IN DAIRYING, F. A. LEIGHTON (pp. 366–368).—Practical suggestions for the management of milk and for butter making.

Kansas Station, Bulletin No. 28, December, 1891 (pp. 12).

SECOND REPORT ON THE EXPERIMENTAL VINEYARD, E. A. POPENOE, M. A., AND S. C. MASON, B. S. (pp. 159–168).—This includes brief descriptive notes on 22 varieties, in continuation of the record in Bulletin No. 14 of the station (see Experiment Station Record, vol. II, p. 566), and on 23 varieties which fruited for the first time in 1891; and accounts of experiments in spraying vines with Bordeaux mixture and in bagging grapes. Of 15 varieties which were more or less affected by the rot even after spraying, "10 were hybrids containing Vinifera blood, 4 were of Labrusca origin, and 1 a Riparia." It was observed

that the fruit of the hybrid varieties would remain in good condition on the vines for weeks after it was ripe. "Aminia, Black Eagle, Creveling, Croton, Barry, Brighton, Duchess, Massasoit, Merrimac, and Wilder are conspicuous examples of this quality. * * * Our trials thus far of these hybrid varieties would encourage the belief that with the aid of the sprayer in summer and a slight amount of protection in winter, the superior qualities of these grapes may be enjoyed in Kansas with considerable regularity."

Analyses of grapes discolored by the Bordeaux mixture showed the presence of only 0.52 grain of copper sulphate per pound of grapes. Paper bags were put on bunches of grapes of different varieties at a cost of about 1 cent per pound.

As to the advantages, the fruit came out of the sacks in the most perfect condition. The ripening in many cases was retarded a few days, and in some sorts the flavor seemed to be somewhat impaired, but with few exceptions both flavor and appearance were perfect. For securing exhibition samples and preserving choice fruit for home use, there can be no doubt as to the advantage of bagging grapes. Whether it would pay on a large scale for market, must depend upon the demand for fancy table fruit at prices above the average for grapes in baskets, as commonly shipped. We were enabled to hold such choice kinds as Black Eagle, Brighton, Delaware, and Lady Washington some time past their season. They can be cut from the vines in the sack, and packed in this way can be shipped long distances without the bloom being disturbed or a berry broken. Where a market can be found for this grade of fruit, at corresponding prices, the outlay would be doubly repaid.

Kansas Station, Bulletin No. 29, December, 1891 (pp. 14).

Experiments with oats, 1891, C. C. Georgeson, M. S., F. C. Burtis, B. S., and W. Shelton (pp. 169–180).—The season of 1891 was very unfavorable to oats. On account of the wet weather it became necessary to reject many of the plats altogether. The experiments were largely a continuation of those made in 1890 and reported in Bulletin No. 13 of the station (see Experiment Station Record, vol. II, p. 122). The plats were in most cases one twentieth acre each in area and when not otherwise mentioned each experiment was repeated on 5 plats located in different parts of the field.

Fall-plowed, spring-plowed, and unplowed land (p. 171).—Pedigree Red Rust-Proof oats were sown on 15 plats, 5 being fall-plowed, 5 spring-plowed, and 5 unplowed. The results were unfavorable to the unplowed land and most favorable to the land plowed in the fall.

Methods of seeding (pp. 171, 172).—Oats were seeded on 60 plats under the following conditions: Broadcast, rolled and not rolled; shoe drilled, with and without press wheels; cross-drilled with hoe drill; drilled with roller drill; listed; sown broadcast with disk harrow; sown broadcast and plowed under; drilled one half and sown broadcast one half.

The results were better where the press wheels were used on the drills and better where the ground was rolled after sowing broadcast than where unrolled; the results where the seed was listed were unfavorable on account of the wet season.

Grading seed oats (p. 173).—"In 1890 we obtained a very marked increase in the yield by grading the seed oats. Three grades were made. One, designated 'common' grade, consisted of the oats as they came from the thresher, in which condition they are ordinarily used by farmers. This grade was run through the fanning mill and separated into 'light' and 'heavy' grades. The light grade consisted of the small oats and the lighter seeds blown out by the fan, the heavy grade being the heaviest and plumpest kernels which the screens could separate from the quantity run through."

The experiment was repeated on a large scale in 1891, but with very different results, the largest average results being where light seed was used. The average yields per acre were as follows: Light seed 50.63, common seed 45.27, and heavy seed 46.44 bushels.

Oats for hay (pp. 173, 174).—The yields of hay from oats are tabulated for 13 different varieties. "For want of room only 1 plat was devoted to each kind and all plats were sown at the rate of 4 bushels per acre. They were cut July 1-3, when most of the seed was in the milk." The yield of hay ranged from 3.1 (Pedigree Red Rust-Proof) to 4.85 (Blue Grazing Winter) tons per acre.

Single variety vs. a mixture of varieties (pp. 174, 175).—As in the previous year, this experiment was only a partial success. The varieties used were Probsteier, Red Rust-Proof, and Black Russian. These were planted singly and in mixtures of twos on 36 plats at the rate of 2.5 bushels per acre. The results were inconclusive, there being a gain in some cases and a loss in others from using a mixture of varieties.

Effect of the degree of maturity of seed oats (p. 175).—The seed of oats which had been cut in 1890 when in the "dough," "hard dough," and ripe stages, was sown on 15 plats. All the plats suffered from the wet weather. The yields in bushels per acre were, seed in dough 38.99, hard dough 28.68, ripe seed 26.66. "There was no perceptible difference in the time these grades matured. All plats were harvested July 17, being equally ripe. The above figures would indicate that seed oats should be harvested in the dough for the best results."

Quantity of seed per acre (pp. 175, 176).—On 36 plats Red Winter oats were drilled at the rate of from 1 to 4 bushels of seed per acre. The average yields per acre with each rate of seeding are tabulated. "After the 2.5 bushels of seed per acre has been reached, the slight increase in yield by thicker seeding does not equal the increase in the seed; in other words, the increase in yield does not cover the outlay for seed. On the other hand, with less seed than 2.5 bushels there is a decided falling off in the yield."

Time to harvest oats (p. 176).—The oats on 14 plats were cut when in the dough state, in the hard dough state, and when ripe. The yields per acre were 32.5, 31.25, and 27.73 bushels, respectively. "The result is the reverse of last year, when there was a slight increase in yield from the dough state until ripeness."

Salt as a fertilizer for oats (pp. 176, 177).—Five plats received salt at the rate of 150 pounds per acre and 5 others alternating with these received no salt. The average yield was 26.87 bushels with salt and 28.62 bushels per acre without salt.

Oats treated with hot water to prevent smut (pp. 177–179).—The seed for 5 plats was treated with hot water to prevent smut and for 5 other plats was left untreated. The variety was in both cases Red Winter. "A careful count at harvest time revealed the fact that the plats on which the seed had not been treated contained 15 per cent of smutted heads, while the crop from the treated seed had none." The yield for treated seed was 37.56 and for untreated seed 29.69 bushels per acre, a gain of nearly 8 bushels per acre from treatment.

Test of varieties (pp. 179, 180).—Tabulated notes on 85 varieties.

Kentucky Station, Bulletin No. 36, December, 1891 (pp. 4).

COMMERCIAL FERTILIZERS, M. A. SCOVELL, M. S.—Analyses of 18 samples of fertilizers, including ground bone and kainit.

Kentucky Station, Bulletin No. 37, December, 1891 (pp. 16).

POTATO EXPERIMENTS.—*Test of varieties* (pp. 3–11).—Notes on 77 varieties of potatoes, together with the yield of large and small tubers, the percentage of dry substance, and the specific gravity.

Test of fertilizers (pp. 12–16).—The ground used for this test was the same as that used in 1889 and 1890. Early Rose potatoes were planted on 10 tenth-acre plats, the seed being cut in halves and placed cut side down and 14 inches apart in the rows, which were 3 feet apart. Nitrate of soda 160 pounds, boneblack 320 pounds, and muriate of potash 160 pounds were used singly, two by two, and all three combined on 7 plats, and 3 plats remained unmanured. Field notes taken during the growing season, yields of potatoes, and the financial results are tabulated. The largest total yield, 210 bushels per acre, was where the three materials were used together, the next largest where muriate of potash and superphosphate were used together. "Potash greatly increased the yield, while phosphoric acid and nitrogen had some beneficial effects. While potash alone has a marked influence in increasing the yield, nevertheless when combined with acid black or nitrate of soda, or both, the yield is still more increased."

The largest net profit was with the use of muriate of potash alone, and the next largest where muriate of potash was used with superphosphate and with superphosphate and nitrate of soda.

Kentucky Station, Bulletin No. 38, March, 1892 (pp. 22).

TESTS OF VARIETIES OF VEGETABLES AND STRAWBERRIES, C. L. CURTIS.—Brief descriptive notes on 17 varieties of onions, 24 of lettuce, 14 of radishes, 34 of peas, 29 of cabbages, 22 of tomatoes, 30 of

beans, 21 of sweet corn, and 17 of cantaloupes. Brief statements are made regarding experiments with strawberries, but dry weather rendered the crop of 1891 almost a total failure. The following varieties of vegetables are especially commended: *Onions.*—Spanish King (Prize-Taker), Yellow Globe Danvers, and Large Yellow Strasburg. *Lettuce.*—Green Fringed, Golden Queen, and French Blockhead. *Radishes,*—Acme, Violet Turnip White Tipped, White Lady Finger, Sandwich, and Early Garnet Turnip. *Peas.*—Henderson First of All, Landreth Extra Early, Dwarf Early Frame, American Wonder, Blue Beauty, and Stratagem. *Cabbages.*—Select Early Jersey Wakefield, Louisville Early Drumhead, All Head Early, Large Flat Dutch, and Premium Flat Dutch. *Tomatoes.*—Early Ruby ("by far the best in our list"), Allen, Lacrosse Seedling, Table Queen, Favorite, Long Keeper, and Paragon. *Beans.*—Improved Golden Wax, Black Eye Wax, Crystal Wax, Valentine, and Mohawk. *Sweet corn.*—Henderson Sugar, Early Landreth, Market, and Early Alaska. *Cantaloupes.*—Salmon and Green, Banquet, Osage, Delmonico, and Turk Cap.

Kentucky Station, Bulletin No. 39, March, 1892 (pp. 11).

PRELIMINARY WORK ON SOME KENTUCKY MARLS, A. M. PETER, M. S.—Remarks on the use of marls for fertilizing purposes and analyses of 29 samples of marls from different parts of the State.

Kentucky Station, Bulletin No. 40, March, 1892 (pp. 51).

SOME COMMON PESTS OF THE FARM AND GARDEN, H. GARMAN (plates 2, figs. 28).—Descriptive notes, with suggestions as to remedies, on the following insects: Hessian fly (*Cecidomyia destructor*), grain louse (*Siphonophora avenæ*), horn fly (*Hæmatobia serrata*), house fly (*Musca domestica*), ox botfly (*Œstrus bovis*), army worm (*Heliophila unipuncta*), tobacco worm (*Phlegethontius carolina*), cutworm (*Agrotis messoria* and *A. subgothica*), wireworm, rose slug (*Selandria rosæ*), imported currant worm (*Nematus ventricosus*), cabbage worm (*Pieris rapæ*), Colorado potato beetle (*Doryphora 10-lineata*), striped cucumber beetle (*Diabrotica vittata*), pea weevil (*Bruchus pisi*), bean weevil (*Bruchus obsoletus*), codling moth (*Carpocapsa pomonella*), plum curculio (*Conotrachelus nenuphar*), tent caterpillar (*Clisiocampa americana*), fall webworm (*Hyphantria cunea*), maple tree bark louse (*Pulvinaria innumerabilis*), and turnip leaf miner (*Drosophila* sp.).

A turnip leaf miner.—In the fall of 1891 leaves of turnips planted near the station were found to be badly blistered by a grub closely allied to *Drosophila flava*. The larva, puparium, and imago are illustrated.

The mines varied at this time (October) from 0.25 to 2 inches in diameter, but in some cases they were confined largely along the veins, sometimes forming galleries above most of the larger of these. They occur in most cases on the upper side and are to be recognized chiefly by their whitish color. * * *

The mines were first noted October 9. At this date many infested leaves were placed under bell jars at the station, and subsequently pupæ and imagos were

secured from them in considerable numbers. On October 13 the confined larvæ were noted as changing rapidly to pupæ and a few days later were all in this stage of development. The pupæ were formed occasionally in the mines, but most grubs made their way out before pupating, and in confinement underwent the change between leaves which lay in contact. In the field it is probable that most of them change among rubbish on the ground under the plants. The pupæ were observed until October 22.

The first adult flies came forth indoors October 23, and others continued to emerge until November 4, at which date the last flies were obtained. An examination of infested plants out of doors showed the flies to be emerging there also, and we must consequently consider this the normal habit of the species. From the lateness at which the adults appear it is altogether probable that the winter is passed in this condition. * * *

The species is very badly affected by a very small four-winged parasitic fly (a new species of ***Polycystus*** according to L. O. Howard), which emerges from the pupæ. These began to emerge from our confined lot of pupæ later than the *Drosophila* and continued to come out at intervals during a considerable part of the winter. The first obtained came forth October 30 and the last January 26, 1892.

Larva.—The grub which produces the mine measures when grown about 5^{mm} (0.2 inch) in length, and 1^{mm} (0.04 inch) in diameter. It is whitish, cylindrical, and wrinkled, and tapers slightly toward the head, but terminates rather bluntly behind. The head segment is small, turns downward, and bears the mouth-opening beneath. From the latter project the tips of the two black hooks common to larvæ of this and related genera. The hooks of this species appear more than usually curved and each bears several strong denticles. At the hind extremity of the body are several fleshy tubercles and a pair of straight protractile spines, which arise from conical prominences. Just in front of the tip of the body is a pair of transversely lengthened sucker-like structures.

Pupa.—The pupa is inclosed in a tough and rather firm reddish brown (fulvous) envelope. The latter resembles in no slight degree the "flaxseed" of the Hessian fly. It is fusiform in general shape, but is rather squarely cut off in front, an angle at each side being formed by the digitate respiratory prominence. The whole anterior part of the puparium is impressed, so that when viewed from the side the ventral outline in this region is seen to be concave. The segments show with tolerable clearness. The two protractile spines of the larva are here thrust out and immovable. Length of alcoholic examples 3.33^{mm} (0.13 inch), diameter 1^{mm} (0.04 inch). * * *

Imago.—The adult is a small brown fly with a wing expanse of about 0.25 inch and measuring about one half this in length of body. The general color of some examples is pale brown, while others are of a much darker brown above and may approach blackness on the sides of the thorax. The thorax is marked above by three narrow stripes, the median and widest one extending upon the scutellum. Head with a dark patch behind each eye and a dark dot including the ocelli. Compound eyes widely separate, reddish brown. Mouth parts pale yellow. Antennæ with the basal segments yellow. Bristle black, with about five branches. Wings hyaline, veins brown. Balancers pale. Legs pale. Abdomen pale beneath. Terga darker, with the hind half of each ring sometimes presenting the appearance of a dusky cross band. Tip of abdomen black. The whole body is more or less thickly clothed with pubescence, which in some regions, particularly on the femora, tends to become arranged in lines. On the head and thorax above are a number of definitely arranged long black hairs.

Length of alcoholic examples $2.2–3^{mm}$ (0.09–0.12 inch).

Massachusetts Hatch Station, Meteorological Bulletin No. 39, March, 1892 (pp. 4).

A daily and monthly summary of observations for March at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

Michigan Station, Bulletin No. 81, March, 1892 (pp. 14).

NOTES ON FRUITS, L. R. TAFT, M. S.—Tabulated data are given for 81 varieties of strawberries, together with brief descriptive notes on 49 of the varieties of strawberries, and also brief notes on experiments with Russian varieties of orchard fruits in the northern part of the State and on the cultivation of the station orchards. General directions are given for the use of fertilizers in orchards. The following varieties of strawberries and raspberries are especially commended:

Strawberries.—Of the extra early sorts, Beder Wood, Lovett, and Van Deman are most promising, to be followed by Haverland, Pearl, Parker Earle, Bubach No. 5, D. & D., and Crescent Glendale. As late sorts, Belle, Florence, and Gandy succeed best here. * * *

Raspberries.—Souhegan, Tyler, and Doolittle still stand at the head of the list of the early black caps; Hopkins follows in a few days. Of the later kinds, Gregg and Nemaha are among the best. Centennial, Kellogg, and Mammoth Cluster are small berries, but the plants are hardy and productive. Ohio is particularly valuable for evaporating and will grow in many localities where other kinds fail. Shaffer is a strong grower, very prolific, and the large showy fruits are excellent for preserving; the color is not particularly attractive and the flavor is peculiar; a demand for it can soon be secured, and it should be very largely planted. For home use a few plants of Caroline will be useful. * * *

Michigan Early and Hansell, which in plant and fruit have many points in common, are among the best early red varieties. Cuthbert although slightly tender here is our best sort for the main crop. Marlboro in some places is an excellent market variety, but it does not prove profitable here. On account of their hardiness, Turner and Thwack seem suited to cultivation in sections unfavorable to fruit. Golden Queen is much like Cuthbert in the color of the fruit and would be valuable for home use.

Michigan Station, Bulletin No. 82, March, 1892 (pp. 18).

SUGAR BEETS IN MICHIGAN IN 1891, R. C. KEDZIE, M. A.—This comprises popular remarks on the principal sources of sugar, suggestions for the growing of the sugar beet, requirements for the establishment of a beet sugar factory, and tabulated results of the cultivation and analyses of sugar beets raised by individuals in different parts of the State.

Sixteen counties report an average product of 15 tons per acre, with 13.84 per cent of sugar in the juice. This is equivalent to \$50 an acre, spot cash, as truly as wheat. Other counties may be as well adapted to the growth of sugar beets, but the reports are too few and incomplete to hazard an opinion. * * *

The results of the season's growth, although the reports are in many instances incomplete, are on the whole very satisfactory. They show that many districts in the State are well adapted to raising sugar beets; that in many counties the farmer can afford to raise sugar beets, and can count upon a good cash return for his land

and labor. But this does not apply to the entire State, for in some districts it would be hazardous to attempt to make the sugar beet a staple crop, and no manufacturer would think of establishing a sugar factory in such localities.

It is worth much to know where we may succeed; it is well to know where we must fail. From the standpoint of the farmer the outlook for the beet sugar industry is promising for a large part of the southern half of our State. The soil and climate of the greater part of Hillsdale and Lenawee counties, for example, would seem to be admirably fitted for this crop.

From the standpoint of the manufacturer the outlook is promising. With an average of nearly 14 per cent of sugar and nearer 15 per cent in some counties, and a coefficient of purity above 80 per cent, the prospect of making sugar at a profit is promising.

Minnesota Station, Bulletin No. 19, March, 1892 (pp. 32).

Dehorning experiment, C. D. Smith, M. S., and T. L. Haecker (pp. 3–6).—An account is given of the dehorning of 9 cows and a record of the yield and composition of the milk for the three milkings preceding and following the operation, and a comparison of this with the record for 6 other cows not dehorned, "which saw the operation and smelled the blood." The summary of results is given in the following table, the first period including the three milkings prior to and the second the three following the operation:

Effect of dehorning on milk yield.

	Nine cows dehorned.	Six cows not dehorned.
Milk yield, first period (pounds)	316.3	196.45
Milk yield, second period (pounds)	294.1	190.25
Shrinkage of milk during second period (pounds)	22.2	6.2
Per cent of shrinkage in milk	7.0	3.0
Yield of fat, first period (pounds)	12.75	9.68
Yield of fat, second period (pounds)	12.28	8.60
Shrinkage of fat (pounds)	0.46	1.08
Per cent of shrinkage in fat	3.0	11.00

It would appear from these observations that while the operation of dehorning may cause a slight temporary variation in the flow of milk and fat content, the normal flow and per cent of fat is quickly recovered, and that cows only seeing the operation and smelling the blood show a greater shrinkage in fat than do the ones dehorned.

A double monstrosity of a calf traceable to injury of its mother, O. Schwartzkopf, D. V. M. (pp. 7–10, figs. 2).—A Holstein-Friesian cow in calf was hooked by another cow while passing into the stables early in October, 1890. A small bruise appeared on the right flank behind the last rib, about 1 foot below the loins. The cow was kept quiet, and apparently recovered in a short time.

On January 28, 1891, the cow dropped a calf. As it did not have any passages within 2 days the cattleman gave it a dose of castor oil, which had no effect. He then reported it to me and also stated that the calf seemed to be crippled. In looking at the calf I observed at once that it had a curved spine, and further examination revealed that there was no rectal opening.

An incision was made where the natural opening should be, but after perforating the skin no rectum was found, but a direct entrance into the abdomen. The intestines that lodged in the pelvic cavity apparently were the colon or cœcum. I tried hard to find the rectum, but did not succeed. On February 3 the calf, which was greatly emaciated, died. The post mortem examination showed the following: On opening the abdomen an irregular situs of the intestines was first noticed. In removing the intestines I found the rectum near the liver, ending in a blind sack, curved, and possessing a kind of nodule resembling somewhat a cicatrix. After the removal of the intestines the curve of the spine to the left was very apparent, and the left kidney was very small and situated on top of the right kidney. The other organs were normal. The calf certainly could not have lived. * * *

By anyone that had examined this case, together with its history, no other conclusion could possibly be reached than to ascribe the cause of the abnormalities of the calf to the blow which its mother received 4 months previous to the birth.

Cream raising by cold deep setting, H. Snyder, B. S. (pp. 11–19).—Studies were made of (1) the rapidity of creaming and its relation to the temperature of the surrounding water, and (2) the time before skimming can safely be done. In these studies determinations were made of the percentage of fat in samples of the milk taken from the top, middle, and bottom of the can at different intervals from the time of setting. The manner of taking these samples was as follows: Perforated corks carrying glass tubes were fastened into a block of wood and placed on the top of the can. The tubes were adjusted so as to reach to the bottom and middle sections of the can. In sampling, a rubber connection was made with a pipette, the pipette filled by suction, and the connection then closed with a pinchcock to prevent disturbance of the milk. The section from the top was taken just below the cream line.

Rapidity of the process and its relation to the temperature of the surrounding water (pp. 11–16).—Determinations were made at frequent intervals of the fat content of samples of milk taken from the top, middle, and bottom of cans of milk set as follows: At 90° F. in water at 40°, at 84° in water at 47°, at 92° in water at 47°, at 82° in water at 48°, at 90° in water at 43°, and at 90° and 93° in water at 47°. The milk as set contained from 4.15 to 5 per cent of fat. The results of these determinations are fully tabulated. From them the author makes the following summary:

(1) The first and most marked action affecting the composition and temperature takes place in the bottom layer, and within 15 minutes this layer will show a less per cent of fat. The temperature of the middle section is affected more slowly and suffers less loss of fat.

(2) The top section, when the action is very rapid, may at the first-hour period contain more fat than the original milk, but as the period increases it grows poorer.

(3) In each of the corresponding periods the top layer is always richer in fat than the middle layer, the middle layer is richer than the bottom, and the bottom layer is always the poorest. During the first 5 or 6 hours the same relationship exists as to temperatures. The middle section has an intermediate temperature between the bottom and top sections, which are respectively the lowest and highest.

(4) At the time of skimming the same relationship of the different sections as to fat exists. This emphasizes the fact that samples of skim milk for analysis must be well mixed in order to obtain a sample that will represent the average composition,

and at no time can a portion be withdrawn from any section and the fat in the whole skim milk calculated from the sample taken.

(5) The temperature of the water at the time of setting is of far greater importance than the temperature of the milk. A reduction of 10° in the temperature of the milk does not appreciably affect the result, while a difference of less than half of this amount in the temperature of the tank water seriously affects the creaming. When the temperature of the tank water is reduced to 40°, about 5 hours' time is required for the different sections to attain a constant temperature, and it is to be observed that during this period the most of the fat is brought to the surface and that during all of this period there is a constant relation between the fall in temperature and fat, the most rapid change in each section being observed when the temperature of that section reaches the temperature of the surrounding water. What the cause of this close relationship is, no satisfactory explanation has yet been given; simply the fact is known, and the dairyman must conform to these temperatures in order to obtain the most beneficial results.

How long before skimming can safely be done (pp. 17–19).—The results of determinations of fat from the top, middle, and bottom of the can of milk set at 90° F. in a tank of water at 60°, "show how slow and imperfect the creaming is when compared with a lower and more favorable temperature, and also how the rising of the fat practically ceases at about the eleventh-hour period." The results are also given of similar determinations in samples of milk set in water at 49°, 52°, and 54° F.

The action is slower and the creaming far less perfect. At the end of 8¾ hours the average per cent of fat in the skim milk, due to the high temperature of creaming, was 1.24 per cent; at the end of 25 hours it was 1.05 per cent.

The average of the eight trials when set at 47° showed that the creaming was practically completed before the end of the 12-hour period, and that the skimming could then safely be done. * * *

The average of twelve trials when set in water at temperatures varying from 50° to 60° F., showed that the creaming was practically completed within the same time. Although a slight gain resulted from a prolonged setting, in no case was this equal to the loss sustained for the want of a lower temperature at the beginning. A prolonged setting can not make up for a low temperature at the time of setting.

EXPERIMENTS IN CHEESE MAKING, H. SNYDER, B. S. (pp. 20–25).—"It has been claimed that when cheese is made from milk rich in fat a large per cent of the total fat is lost in the whey, and that when the per cent of fat in the milk reaches a certain point all the fat above that point is lost in the whey and no more can be retained in the cheese. To test this question a large number of trials were conducted in making cheese from milk containing from 3.5 to 5.5 per cent of fat. A summary of the results of these trials is given below.

Cheese made from milk of different fat content.

Number of trials.	Range of percentages of fat in milk.	Per cent of fat in milk.	Per cent of fat in whey.	Pounds of milk.	Pounds of green cheese.	Pounds of milk to make 1 pound of green cheese.
28	3.5–4.0	3.85	0.38	304.7	31.46	9.68
31	4.1–4.4	4.29	0.36	305	32.80	9.30
14	4.5–4.9	4.62	0.39	304.3	34.2	8.90
4	5.0–5.4	5.05	0.32	305	35.5	8.56

In these experiments, in which the cheese was made under the same conditions, the losses of fat in the whey are practically the same whether the original milk was rich or poor in fat; and normal milks rich in fats were made into cheese without any greater percentage loss of fat in the whey than poorer milk. It is also noted that where the milk was rich in fat it required a smaller number of pounds to make a pound of cheese.

In view of the results obtained with rich milk, trials were made to determine whether cream can be successfully incorporated into cheese. In these trials cream was added until the milk contained from 5.4 to 6 per cent of fat and comparisons were made with normal milk containing 2.8 to 4 per cent of fat. The results indicate that in these trials the addition of cream involved no additional loss of fat in the whey, although "a greater loss did result from the pressing of the creamed milk; this, however, amounted to only a small per cent of the fat added. Whether this loss will be more than balanced by the increase in the price received for this cheese, remains to be seen."

In each case where cream was added the weight of the green cheese obtained always exceeded that made from the same normal milk by more than the weight of the fat added to the cream. * * *

If it can not be demonstrated that with normal milk rich in fat intelligent cheese makers can so incorporate the fat in the cheese as to leave as small a per cent of fat in the whey as with poorer milk, many patrons owning herds of cows giving rich milk must advocate partial skimming at least. These experiments, however, seem to show that with rich milk the loss of fat in the whey is relatively less than where poor milk is used. The per cent of fat in the whey remains about constant—a little less than 0.4 per cent, without regard to the quality of the original milk.

THE BABCOCK TEST AND CHURN, C. D. SMITH, M. S., AND T. L. HAECKER (pp. 26–32).—To study the correspondence between the amount of fat indicated by the Babcock test in whole milk of an individual cow and the amount of fat recovered in the butter, buttermilk, and skim milk from the same, 13 separate tests were made with 8 different cows, all fresh in milk. The tests were made during the month of December. In each case allowance was made for the amount of fat contained in the sample for analysis.

"The milk was run through a hand centrifuge immediately after weighing, care being taken to wash all the cream from the bowl by liberal additions of skim milk at the completion of the separation of each mess of each cow. The cream was then cooled and kept until seven milkings had accumulated, when it was ripened and churned. Both the skim milk and the buttermilk were tested with the Babcock test."

The results of each experiment are fully tabulated and summarized. These show a discrepancy between the amount of fat in the whole milk and that recovered ranging from -0.3066 to $+0.1278$ pound, but the average difference was relatively smaller.

Nebraska Station, Bulletin No. 20, March 25, 1892 (pp. 37).

Meteorological observations for 1891, DeW. B. Brace, Ph. D. (pp. 215-251).—These were in continuation of those reported in Bulletin No. 17 of the station (see Experiment Station Record, vol. III, p. 29) and included the ordinary meteorological observations taken at the University of Nebraska and data from evaporimeters, rain gauges, and soil thermometers on the station farm. The yearly summary of meteorological observations is as follows: *Pressure* (inches).—Maximum 30.92, minimum 29.40, mean 30.09, annual range 1.52, maximum daily range 0.75. *Air temperature* (degrees F.).—Maximum 95, minimum —12, mean 49.07, annual range 107, maximum daily range 44. *Humidity.*—Mean relative humidity 71.89. *Precipitation.*—Total (inches) 39.605, total snowfall (inches) 22.22, number of days on which 0.01 inch or more of rain fell 83. *Weather.*—Number of clear days 128, number of fair days 135, number of cloudy days 102. *Wind.*—Maximum velocity (miles per hour) 64, total movement (miles) 125,164.

The mean relative evaporation at different elevations for each month from April 21 to November 10 is as follows:

Mean relative evaporation at different elevations.

	3 feet.	20 feet.	40 feet.	60 feet.	80 feet.	98 feet.	Mean.
April 21-30	7.1	18.5	17.6	20.2	21.1	21.7	16.1
May	4.3	11.7	12.3	13.3	14.3	15.8	11.6
June	3.3	8.6	9.8	10.3	11.5	12.1	9.3
July	3.3	8.2	9.4	9.5	10.9	11.6	8.7
August	3.6	9.5	10.1	11.4	11.2	12.8	9.7
September	4.9	13.9	16.1	17.3	18.0	19.2	14.3
October	3.9	10.0	11.8	12.7	13.4	13.6	10.8
November 1-10	2.8	7.3	8.8	9.6	10.6	10.7	8.3

Monthly maximum and minimum air and soil temperatures.

[In degrees F.]

1891.	Air.		1 inch.		3 inches.		6 inches.		9 inches.		12 inches.		24 inches.		36 inches.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January	....	....	31.9	21.0	35.1	22.7	36.2	25.6	36.3	30.0	36.5	31.4	39.2	35.7	41.6	38.5
February	....	....	32.3	11.5	31.7	14.6	31.0	17.7	32.0	23.5	32.6	24.2	35.9	31.4	38.4	34.8
March	....	....	39.7	15.3	41.6	16.4	40.3	18.6	37.8	22.5	36.9	22.8	35.9	30.0	36.4	33.2
April	....	....	71.3	32.6	69.5	33.7	65.9	34.2	63.3	35.5	60.9	35.7	54.3	36.2	50.6	36.5
May	....	....	80.2	50.5	77.3	51.7	75.2	52.7	71.9	53.7	69.0	53.0	59.9	52.1	86.0	50.9
June	92.2	48	79.9	56.6	84.1	57.1	81.5	59.0	78.7	59.7	75.4	59.9	67.3	59.6	64.0	56.8
July	91	46	83.5	63.5	82.4	63.7	78.3	67.7	75.9	67.8	73.9	68.4	72.9	66.5	57.0	64.1
August	94	48	84.7	60.5	84.8	62.9	82.8	62.3	80.4	67.0	77.6	67.1	72.3	68.1	69.6	67.0
September	92	34	81.4	57.2	79.9	63.0	78.2	60.4	76.0	64.5	75.8	65.2	69.6	66.5	67.5	65.8
October	85	28	68.5	42.0	67.8	44.3	67.8	45.0	67.6	42.3	66.6	50.5	66.0	53.8	66.2	55.2
November	78	3	51.3	23.6	52.6	26.3	50.6	30.5	51.2	35.0	51.0	37.3	53.8	42.8	55.2	46.0
December	64.5	−1	44.8	27.3	44.9	29.2	42.6	31.1	42.2	34.0	42.3	35.0	43.3	39.0	45.9	42.0
June 1 to December 31	94	−1	84.7	11.5	84.8	14.6	82.8	17.7	80.4	22.5	77.6	22.8	72.9	30	69.6	33.2

Nebraska Station, Bulletin No. 21, March 1, 1892 (pp. 44).

EXPERIMENTS IN THE CULTURE OF THE SUGAR BEET IN NEBRASKA, H. H. NICHOLSON, M. A., AND R. LLOYD, PH. D. (plate 1, figs. 8, charts 6).—An account of work in continuation of that reported in Bulletins Nos. 13 and 16 of the station (see Experiment Station Record, vol II, pp. 111 and 731). Relatively less attention was given to the analysis of beets from different parts of the State and more to the collection of information regarding the yield and the cost of raising the beets. The data recorded were obtained from experiments at the station and by farmers in Nebraska, Utah, and California.

The experiments at the station were in three series, (1) planting at different dates; (2) test of implements; and (3) test of varieties, fertilizers, etc.

Planting at different dates.—Seeds of the Klein Wanzleben variety were planted at intervals of 1 week from April 11 to June 15, inclusive, on fortieth-acre plats of very fertile soil. After May 10 the ravages of cutworms were very severe, so that no record is made for any planting later than May 16. Details are given in notes and the results are summarized in the following table:

Plat.	Date of planting.	Time of germinating.	Time of appearing above ground.	Time of reaching four leaves.	Date of thinning.	Sugar content.	Purity.	Yield per acre.
		Days.	*Days.*	*Days.*		*Per cent.*		*Tons.*
1	Apr. 11	7	9	15	Apr. 27	14.8	80.0	34.0
2	Apr. 18	8	10	16	May 11	13.0	82.1	31.0
3	Apr. 18	6	9	14	May 11	13.5	79.9	31.3
4	May 2	7	8	12	May 18	14.2	82.0	30.5
5	May 9	6	11	20	June 9	12.9	84.2	30.8
6	May 16	8	8	16	......	......	......	......
Average	....	7	9	15.5	....	13.7	81.6	31.5

On 2 plats the beets were left in the ground when the others were harvested (November 9). After the ground had frozen to a depth of 6 or 8 inches one of the plats was covered with 6 inches of straw. Analyses of beets taken from each plat from time to time up to January 6 showed little difference in the sugar content.

"The entire expense of this series, including preparation of ground, seed, seeding, cultivation, harvesting, topping, and placing in the cellar, was at the rate of \$32.75 per acre."

Test of implements.—Accounts of successful tests of the Moline beet seeder and cultivator, the Deere & Mansur implement for loosening the beets in the ground, Planet jr. seed drill and hand plow, and the Kirkwood & Miller hand cultivator. The Coryell and Moline implements for topping and digging the beets were not successfully used. Most of the implements used are illustrated.

Tests of varieties, fertilizers, etc.—These were on 28 plats, varying in area from one fortieth of an acre to one acre. Notes and tabulated

data are given for Lemaire, Desprez, Vilmorin, Klein Wanzleben, and Knauer varieties. The differences in yield and sugar content were not large. The averages were as follows: Yield per acre 15.58 long tons, cost per acre $29.14, sugar content 13.3 per cent, purity 80.4. The much larger yield obtained in the experiment of the first series is thought by the author to be due to the fact that the ground used in that case had been thoroughly fertilized and cultivated for several years previous to its use for beet growing. It was found that beets grown on soil previously occupied by corn gave smaller yields than where barley or oats had been the previous crop.

In another experiment bone dust and kainit alone, and these fertilizers and nitrate of soda, guano, and phosphate in different combinations, were used on Klein Wanzleben beets and compared with no manure. The results, as tabulated, do not indicate any advantage from the use of the fertilizers.

Planting at a depth of 1 inch gave better results than at depths of 2 to 6 inches. The increase or decrease in the weight of the leaves and roots of the 5 varieties tested was determined for beets harvested July 17, August 24, and November 20. The results for the Klein Wanzleben variety were as follows:

	Date of harvesting.		
	July 17.	Aug. 24.	Nov. 20.
	Ounces.	*Ounces.*	*Ounces.*
Entire plant	12	79	67
Leaves	9.5	42	21
Root	2.5	37	46
Increase in weight of leaves		32.5	
Decrease in weight of leaves			†21
Increase in weight of roots		*34.5	†9
Per cent of increase in juice			14.1

*July 17 to August 24—38 days. †August 24 to November 20—88 days.

To hinder the second growth of beets caused by fall rains, which resulted in a decreased sugar content, loosening the beets in the bed sufficiently to break the roots without disturbing the surface of the ground, was tried. Comparative analyses, as tabulated, indicate that loosening the beets increased the sugar content, beets thus treated averaging 1.3 per cent more sugar than those untreated.

General data for beet culture in Nebraska in 1891.—Tabulated data are given regarding beets raised in different parts of the State, including the sugar content, and in many cases the yield and cost per acre. Especial attention is called to the results at Grand Island. The financial results varied greatly. Some farmers realized a large profit while others suffered more or less loss. Only on a small scale was the culture of beets profitable. Those persons who had had previous experience in beet culture obtained the best results. Both 1890 and 1891 were unfavorable seasons for beet growing, the former being hot and dry and the latter cold and wet.

Detailed data are given showing the cost of raising beets in several places in California and Utah.

The following summary is taken from the bulletin:

(1) The best results are reached on land that has been longest under cultivation and has received deep and thorough tillage.

(2) Thus far land that has been occupied the previous year by corn does not seem to be well adapted to beet growing.

(3) Fall preparation of ground, deep plowing, and subsoiling are advisable, followed, if possible, by surface plowing in the spring.

(4) Early planting is urged both for the purpose of giving the plants a strong start and also as a guard against cutworm ravages.

(5) Hoe as soon as the rows can be seen.

(6) Thin when two thirds of the plants have four leaves.

(7) Thus far the Klein Wanzleben, Desprez, Vilmorin, Knauer, and Lemaire seem to be the best varieties for this State.

(8) Fifteen tons, with a sugar content of 13.5 per cent, is a fair average yield for the whole State.

(9) These results can be reached at an average cost of $30 per acre if the cultivation indicated is given at the right time.

(10) Sugar beets make one of the best of cattle foods, of especial importance in the West, where nitrogenous cattle foods are relatively scarce.

Nevada Station, Fourth Annual Report, 1891 (pp. 32).

This contains brief statements regarding the work in the several departments of the station, and a financial report for the fiscal year ending June 30, 1891. Besides references to the work reported in Bulletins Nos. 12 to 15 of the station, notes and tabulated data are given for tests of varieties of wheat, oats, barley, corn, flax, ramie, buckwheat, broom corn, sorghum, tobacco, and different kinds of vegetables. The yields of wheat are tabulated for fourth-acre plats where 45, 75, 90, and 105 pounds of seed per acre were used. The yields were the same with 75 and with 105 pounds per acre and were larger than where 40 or 90 pounds were used. The results obtained in the growth of sugar beets "justify the conclusion that beets of a very high sucrose percentage can be produced in Nevada." The report is illustrated with 8 plates showing the exterior and interior of the station building, and specimens of corn grown at the station.

Nevada Station, Bulletin No. 14, December, 1891 (pp. 18).

Potato experiments, R. H. McDowell, B. S., and N. E. Wilson, B. S.—Notes and tabulated data are given for 52 varieties of potatoes grown in 1891. The percentages of water, dry matter, and starch in the several varieties are also tabulated. The starch varied from 12.32 to 23.03 per cent, being over 15 per cent in 37 varieties. Data are given on the methods of potato culture employed by five farmers in different localities in the State.

Nevada Station, Bulletin No. 15, January, 1892 (pp. 8).

DODDER, F. H. HILLMAN, B. S. (figs. 5).—A general account of plants of the genus *Cuscuta* and brief descriptions of *Cuscuta epithymum*, *C. arvensis*, and *C. denticulata*, with suggestions regarding means for the repression of these parasites. The first-named species is prevalent on alfalfa in Nevada. Seeds of *C. arvensis* were found in imported alfalfa seed. "The first year's growth of alfalfa [from these seeds] showed the effect of the presence of the parasite in the yellowish red patches of repressed plants, about which the dodder formed a dense mat."

New Mexico Station, Second Annual Report, 1891 (pp. 10).

This includes brief statements regarding the work of different departments of the station, including experiments with orchard and small fruits, nuts, vegetables, cereals, and grasses. The results of analyses of different varieties of sorghum are tabulated and a financial statement is given for the fiscal year ending June 30, 1891.

North Carolina Station, Bulletin No. 83, February 19, 1892 (pp. 20).

CULTURE OF CELERY AND ONIONS IN THE SOUTH, W. F. MASSEY, C. E. (pp. 4–12).—This is the first of a series of popular papers on the culture of crops which may be advantageously grown in the region of the station.

NOTES ON HORTICULTURAL WORK DURING 1891, W. F. MASSEY, C. E. (pp. 13–20).—Brief accounts are given of tests of varieties and other experiments with peas, sweet corn, tomatoes, potatoes, lettuce, radishes, strawberries, raspberries, blackberries, gooseberries, currants, grapes, figs, and Japanese oranges. Brief descriptive notes are given on 30 varieties of tomatoes, 9 of lettuce, 5 of radishes, and 7 of strawberries. Crosses of varieties of sweet corn have been made for several years with a view to develop a variety especially adapted to the region of the station. The results thus far obtained indicate that a variety has been produced that is much earlier than the varieties from which it originated.

North Carolina Station, Bulletins Nos. 83a and 83d (Meteorological Bulletins Nos. 28 and 29), February 20 and March 29, 1892 (pp. 16 each).

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, JANUARY AND FEBRUARY, 1892, H. B. BATTLE, PH. D., AND C. F. VON HERRMANN.—Notes on the weather, monthly summary, and tabulated records of meteorological observations by the North Carolina weather service coöperating with the U. S. Weather Bureau. The bulletins are illustrated with maps showing the isothermal lines and the total precipitation at the stations in different parts of the State.

North Dakota Station, Bulletin No. 5, February, 1892 (pp. 50).

EXPERIMENTS WITH SUGAR BEETS IN NORTH DAKOTA IN 1891, E. F. LADD, B. S. (figs. 4).—These were under the direction of the State commissioner of agriculture and the station. Notes and tabulated data regarding culture, yield, and sugar content are given for 129 samples analyzed. The varieties tested were Russian Imperial, Vilmorin Improved, Desprez, Lemaire Frères, and Dippe Klein Wanzleben. The average per cent of sucrose was 11.43. Many of the beets were harvested too early. The author does not think that the sugar beet industry is likely to prove profitable in North Dakota.

Ohio Station, Bulletin Vol. IV, No. 10 (Second Series), December, 1891 (pp. 51).

TENTH ANNUAL REPORT, 1891.—This includes the reports of the board of control, treasurer (for the fiscal year ending June 30, 1891), director, agriculturist, horticulturist, consulting entomologist, botanist, and meteorologist. These reports consist for the most part of brief outlines of the work of the year. A table of contents of the bulletins of 1891 is given in an appendix, and brief synopses of these are contained in the Director's report. There is also an index to the publications of the year. The report of the board of control contains the text of the act authorizing the several counties of the State to raise money to secure the location of the station, as a result of which proposals were received from several counties, the largest, $85,000, coming from Wayne County. The station has been located about 1 mile from the city of Wooster, Wayne County, and 452 acres of land have been purchased. An appropriation of $47,350 is asked from the general assembly for the erection of buildings, fencing, draining land, purchase of live stock, etc.

Report of Meteorologist, W. H. Baker.—This includes tabulated daily and monthly summaries of observations at the station and for the State of Ohio and a yearly summary for each year from 1883 to 1891, inclusive. The yearly summaries for 1883–90 were published in the Annual Report of the station for 1890 (see Experiment Station Record, vol. III, p. 176). The yearly summary for 1891 for the State of Ohio is as follows: *Air temperature* (degrees F.).—Maximum 101, August 10; minimum −5, March 5; annual range 106; maximum daily range 50, April 27 and 30; minimum daily range 2, January 4 and 11, March 19 and 22, November 12, and December 4; mean daily range 20. *Humidity.*—Mean relative humidity 78 per cent. *Wind.*—Prevailing direction SW. *Precipitation.*—Total rainfall 38.61 inches; mean daily rainfall 0.11 inch; number of days on which rain fell 120. *Weather.*—Number of clear days 133; number of fair days 109; number of cloudy days 137.

Ohio Station, Bulletin Vol. V, No. I (Second Series), January, 1892 (pp. 20).

EXPERIMENTS WITH OATS, J. F. HICKMAN, M. S. A.—These experiments included comparison of varieties, amount of seed, sowing broadcast *vs.* drilling, and treatment for smut. They were conducted during 1890 and 1891 and were largely in continuation of experiments in previous years.

Comparison of varieties (pp. 3–13).—In 1890, 54 varieties were tested, and in 1891, 50 varieties. In 1890 the oats suffered from an unknown disease; in 1891 the season was reasonably favorable throughout and there was but little appearance of disease. The results for both years are tabulated and discussed at length.

Out of the 54 varieties grown in 1890 only 10 yielded over 30 bushels per acre. The Improved American, Dakota Gray, White Canadian, and State of North Dakota gave the highest yields under the adverse conditions of that season. The average yield of the 10 most productive varieties for 1890 was 32.48 bushels. For 1891 the average yield of the same 10 was 52.64 bushels. These figures show that under favorable conditions these varieties have yielded 60 per cent more than under the unfavorable circumstances of the preceding year and indicate the loss sustained by the farmers of the State as a result of the oats disease previously mentioned. * * *

We have harvested on the average about 46 pounds of grain per acre more from the Wide-Awake than from the Welcome and about 279 pounds more from the Seizure than from the Welcome. The lowest yield of Seizure is higher than the highest of either Welcome or Wide-Awake. * * * We are therefore abundantly justified in assuming that for this season and for this rich bottom land the Seizure and a few other varieties of its type have proved decidedly more productive than those of the Welcome and Wide-Awake types. * * *

[From the yield of 23 varieties during 6 years—1886–91—] it appears that the varieties of the Welcome type have given the lowest yield on the average, those of the Wide-Awake type surpassing them by 5 bushels per acre, and the mixed and black oats giving a yield still greater. The largest average yield over this 6-year period has been given by Probsteier, which is closely followed by Early Dakota of the same class, and by Black Tartarian and Monarch of the mixed varieties, while State of North Dakota, Rust-Proof, Kansas Hybrid, White Schönen, and Black Russian all show average yields exceeding 50 bushels.

In the weight per bushel of these varieties over the same 6-year period, we find here a marked difference in favor of the Welcome group, which is explained by the shorter, plumper berry of that class of oats. We have harvested on the average a smaller weight of grain from the Welcome than from either of the other classes. Just what proportion of this weight is husk or chaff in the different classes we are not yet prepared to state. * * *

Nearly a million acres are annually sown to oats in Ohio. To increase this crop by 3 bushels per acre, which these experiments show to be quite within the bounds of possibility, would add a million dollars annually to the income of the farmers of the State.

The results of tests of varieties made by farmers in the State in 1890 are tabulated.

Quantity of seed (pp. 14–16).—In 1890 oats were drilled on 11 plats at rates ranging from 2 to 12 pecks of seed per acre, and in 1891 at rates ranging from 4 to 9 pecks per acre. "In 1890 wet, cold weather and the oat disease cut the crop down almost to a failure." In 1891 there

was "a slight advantage in favor of the 7 and 8-peck rates over either a higher or lower rate of seeding." The average results are given for 4 years, in which from 4 to 9 pecks of seed were used per acre.

Methods of planting (p. 16).—In a comparison in 1890 and 1891 of drilling the seed from 1 to 3.5 inches deep, "oats planted more than 2 inches deep did not give as good results as those drilled 1, 1.5, and 2 inches deep." Brief mention is made of tests of preparing corn stubble for oats by plowing and by thoroughly cultivating and harrowing, and of rolling land before and after seeding.

Treatment for smut (pp. 17–20).—In 1890 an acre of land was divided into two equal parts, the seed for one part being sown broadcast in its natural condition and that for the other first treated by soaking in hot water according to the Jensen method to prevent smut.

By counting 10,000 heads in different parts of the field, we found that where the seed was not treated 6.6 per cent of the heads were smutted, while only 2.1 per cent were damaged where the seed had been put through the Jensen process. In other words, 68 per cent of the damage which might have been caused by the smut had apparently been prevented by the treatment. * * *

The entire cost of treating the seed for a 10-acre field need not exceed $1.50, and if we can save by this method 68 per cent of what might otherwise be lost, we shall save in a crop averaging 32 bushels to the acre, 1.43 bushels per acre, or 14 bushels from a field of 10 acres.

Oregon Station, Bulletin No. 16, February, 1892 (pp. 9).

Notes on varieties and yield of wheat, H. T. French, M. S., and C. D. Thompson, B. A. (plate 1).—Tabulated and descriptive notes on 64 varieties of wheat.

Oregon Station, Bulletin No. 17, February, 1892 (pp. 20).

Sugar beet culture in Oregon, G. W. Shaw, M. A., and D. Lotz, M. S. (plates 4).—This contains general information regarding the beet sugar industry and sugar beet culture, together with notes and tabulated data on the climate of Oregon and on 95 samples of sugar beets grown in the State in 1891 and analyzed at the station. There is also a brief record of some preliminary experiments begun under direction of P. H. Irish, Ph. D., the former chemist of the station, in 1890. Of the 95 samples analyzed in 1891, 8 contained less than 10 per cent of sugar, 76 over 12 per cent, and 37 over 14 per cent. The experiment will be continued the present year.

Utah Station, Bulletin No. 11, April 1, 1892 (pp. 11).

Influence of shelter on food consumption, J. W. Sanborn, B. S.—The trials here reported include blanketing continuously *vs.* not blanketing for horses; blanketing *vs.* not blanketing for steers, feeding steers in barn and in open air without shelter; and feeding steers in the barn with outdoor exercise and loose in box stalls without exercise.

Horses wearing blankets beneath their harness in the day and blanketed in the stables at night did not hold their weight as well as those without blankets.

Cattle with blankets in the stable did not thrive as well as those without blankets.

Steers turned out daily and those kept in loose box stalls did better than those tied up, indicating that exercise or liberty is beneficial.

Utah Station, Bulletin No. 12, March, 1892 (pp. 12).

TESTS OF VARIETIES OF VEGETABLES, E. S. RICHMAN, B. S.—Notes on 37 varieties of sweet corn, 25 of radishes, 23 of beets, and 38 of lettuce. The following varieties are especially commended: *Sweet corn.*—Early Marblehead, Cory, Landreth Sugar, and Old Colony. *Radishes.*—Salzer Twenty-Day Forcing (early), New White Strasburg (second early), Celestial (summer), and Chinese White (winter). *Beets.*—Salzer Red Beauty (early), Half Long Blood, and Red Beauty (late).

Washington Station, Bulletin No. 3, February, 1892 (pp. 30).

REPORT OF FARMERS' INSTITUTE AT GARFIELD, WASHINGTON (pp. 41–70).—This includes papers and discussions on the following subjects at the farmers' institute held at Garfield, Washington, February 20, 1892: Government Aid for the College, by G. Lilley, Ph. D.; The Sugar Beet, by C. A. Gwinn; Farm Dairying, by J. O'B. Scobey, M. A.; The Pathology, Causes, and Treatment of Bone Spavin, by C. E. Munn, V. S.; Wheat Growing, by R. C. M'Croskey; A Word about Wind-Breaks, by E. R. Lake, M. S.; Handling and Marketing Grain, by J. O. Courtright; and Strangles or Colt Distemper, by C. E. Munn, V. S.

West Virginia Station, Bulletin No. 20, January, 1892 (pp. 18).

POTATO CULTURE AND FERTILIZATION, D. D. JOHNSON, M. A. (pp. 131–143, plate 1).—Trials were made on 10 plats of completely worn-out land, each 1 rod wide and 8.36 rods long, with the primary object of determining the effect of kainit used alone and in combination with phosphoric acid and nitrogen, and to test the effects on the yield of using different amounts of seed cut to halves, quarters, and single eyes. The plats were separated by unfertilized strips 3 feet wide, 1 plat remaining unmanured. On the other 9 plats 21, 31.5, and 42 pounds of kainit, respectively, were used alone, and the last two amounts were also used with 8.34 pounds of nitrate of soda or 21 pounds of superphosphate, or both. The potatoes were planted in rows 3.83 feet apart running across the plats, 36 rows on each plat. The first 12 rows of each plat were planted with Early Rose, the second with White Star, and the third 12 with Beauty of Hebron. In the case of each of these varieties whole potatoes, halves, quarters, and single eyes were planted. The yields of large and small potatoes with different fertilizers and the yield of tubers and number and vigor of stalks from using whole potatoes and pieces of potatoes for seed, are tabulated, and the plate shows the tubers and plants from fertilized plats. In general the yields

were larger with 42 pounds of kainit than with 31.5 or 21 pounds. Where superphosphate was used with the kainit there was a marked increase in the yield. The increase with nitrate of soda was very small. There was a profit from the use of fertilizers on all plats except the 1 receiving 31.5 pounds of kainit with nitrate of soda. The smallest profits were when kainit was used alone, and the largest where 42 pounds were combined with 21 pounds of superphosphate. In the case of the White Star and Beauty of Hebron, "the halves, quarters, and single eyes produced decidedly more than the whole potatoes." With Early Rose the results were variable. With regard to the number and vigor of the stalks from different-sized seed—

We find that in all varieties the whole potato produces a greater number and more vigorous stalks than either the halves, quarters, or single eyes, and that the general rule is a gradual diminution of the number and vigor of the stalks as the size of the pieces planted diminishes, until we reach those cut to one eye in each piece, when we find that the number of the stalks is very materially increased. * * * Of those cut to single eyes, nearly all germinated. We further find that the increased yield is not in proportion to the increase of the number of stalks. From these facts we infer that in the preparation and planting of the seed to secure the best results, the potato should be so cut as to secure one strong, vigorous stalk from each piece, and planted so as to secure from three to four stalks to each hill.

Test of varieties of tomatoes, D. D. Johnson, M. A. (pp. 144–148).—Tabulated notes for 6 varieties, showing date of ripening and the average daily and weekly yields during the bearing season. The varieties are commended in the following order: Brandywine, Ignotum, Cumberland Red, Early Market Champion, Atlantic Prize, and the Mikado or Turner Hybrid.

West Virginia Station, Bulletin No. 21, April, 1892 (pp. 27).

Methods of dealing with injurious insects and plant diseases, A. D. Hopkins and C. F. Millspaugh, M. D. (pp. 151–175, figs. 9).—Compiled information regarding methods for the repression of injurious insects and fungi, with formulas for insecticides and fungicides. Spraying apparatus is described and illustrated.

Wisconsin Station, Bulletin No. 30, January, 1892 (pp. 32).

Sugar beet experiments in Wisconsin in 1891, F. W. Woll, M. S.—Notes and tabulated data on experiments at the station and by farmers in different parts of the State. The results in the different counties of the State are also shown on a map accompanying the text. At the station the beets were grown on about 2 acres of light clayey loam. "The following 11 varieties were planted on May 26 and 27: Le Maire Richest, Simon Le Grande, Vilmorin, Klein Wanzleben, Bulteau Desprez, Desprez B. & R., La Plus Riche, F. Kroemer, O. B. S. & Co., French, and German. The first 9 varieties were obtained from the Oxnard Beet Sugar Company, Grand Island, Nebraska, and the last

2 varieties from the U. S. Sugar Experiment Station at Schuyler, Nebraska." The meteorological data given show that the precipitation for the summer months of 1891 was only 11 inches, or about half the normal amount. The latter part of the season was especially dry. As a result "the beets were very small, averaging only about 11 ounces for all the varieties. The average per cent of sugar (sucrose) in the juice at harvesting time was 17.83, ranging from 14.99 to 20.53. The average per cent of sucrose in the beets was 15.5, with 13.27 and 17.56 as lowest and highest limit. * * * The beets yielded 7⅓ tons to the acre, and a little more than 1 ton of sugar to the acre. In 1890, under favorable conditions of weather, the yield was 15 to 26 tons per acre, with an estimated yield of 2 to 3½ tons of sugar per acre." The cost of growing and harvesting the beets is estimated at $3.76 per ton, reckoning that the tops, which yielded more than 2 tons per acre, paid for rent of land, seed, and wear of machinery.

Imported White Imperial sugar beet seed was distributed by the station in pound packages to 851 farmers. Three hundred and seventy-three samples from 59 of the 68 counties in the State were received at the station and analyzed by the author. The results of the analyses of these samples are tabulated, as well as those of 20 samples sent to the U. S. Department of Agriculture. The following summary of the results of the season's work is taken from the bulletin:

The 11 varieties grown at the University farm during the season of 1891 contained from 14.99 to 20.53 per cent sugar in the juice; the average yield of washed beets per acre was 14,677 pounds. On account of the severe drouth the crop was less than one half; the per cent of sugar in the beets was somewhat increased from the same reason.

Of the 373 samples of beets received from farmers in all parts of the State, 175 samples showed above 13 per cent sugar in the juice, the richest being 23.52 per cent and the poorest 7.12 per cent. * * *

Fifteen counties furnished beets analyzing on the average above 13 per cent of sugar in the juice; beets analyzing on the average above 14 per cent were received from the following counties: Door, Green, Jefferson, Lincoln (only one analysis), Pepin, Racine, Sauk, Trempealeau, and Washington. These counties do not belong to any single section of the State, but are scattered all around, in the western, southern, and northeastern portion of the State. * * *

The results of the work done by this station during the past 3 years indicate that Wisconsin can grow beets in sufficient quantity and of a good percentage of sugar; if this is correct, manufacturing of beet sugar will be a success with us when enough beets can be obtained to supply a beet factory.

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

DIVISION OF VEGETABLE PATHOLOGY.

JOURNAL OF MYCOLOGY, VOL. VII, NO. 2, MARCH 10, 1892 (pp. 65–194, plates 8).—This number includes articles on A Disease of Almond Trees (*Cercospora circumscissa*, Sacc.), by N. B. Pierce (plates 4); Suggestions in regard to the Treatment of *Cercospora circumcissa*, by B. T. Galloway; Club Root in the United States, by A. C. Eycleshymer (plates 2); Field Notes, 1891, on Peach Curl (*Taphrina deformans*), Peach Mildew (*Sphærotheca pannosa*), Black Spot of Peaches (*Cladosporium carpophilum*), Frosty Mildew (*Cercosporella persica*), Peach Rust (*Puccinia pruni-spinosæ*), Peach Rot (*Monilia fructigena*), Peach Yellows, Clubbed Branches, Stem and Root Tubers, Peach Rosette, Plum Blight, Pear Diseases, and Sycamore Blight (*Glœosporium nervisequum*), by E. F. Smith; New Fungous Diseases in Iowa, by L. H. Pammel; Remarks on the Fungus of a Potato Scab (*Spongospora solani*), by G. de Lagerheim; Description of Two New Species of Peronospora (*Peronospora celtidis* and *P. hydrophylli*), by M. B. Waite (plates 2); Some *Peronosporaceæ* in the Herbarium of the Division of Vegetable Pathology, by W. T. Swingle; New Species of Fungi, *Puccinia suksdorfii*, *Puccinia agropyri*, *Strictis compressa*, *Tryblidiella pygmæa*, *Valsaria hypoxyloides*, *Phyllosticta gelsemii*, *P. rhododendri*, *Sphæropsis albescens*, *Stagonospora spinaceæ*, *Septoria elymi*, *Septoria jackmani*, *S. saccharina*, *S. drummondii*, *Hendersonia geographica*, *Glœosporium catalpæ*, *G. decolorans*, *Melanconium magnoliæ*, *Pestalozzia lateripes*, *Scolecotrichum caricæ*, *Macrosporium tabacinum*, *M. longipes*, *Brachysporium canadense*, and *Clasterosporium populi*, by J. B. Ellis and B. M. Everhart; Reviews of Recent Literature; A Provisional Host Index of the Fungi of the United States, Cambridge, W. G. Farlow and A. B. Seymour; *Phycomycetes*, Rabenhorst's Kryptogamenflora, Leipzig, A. Fischer; Fruit Culture in Foreign Countries, Department of State, Washington; *Sur la callose, nouvelle substance fondamentale existant dans la membrane*, *Sur les réactifs colorants des substances fondamentales de la membrane*, *Sur la structure des Péronosporées*, *Sur la désarticulation des conidies chez les Péronosporées*, *Compt. rend.*, 110 (1890), p. 644; 111, (1890), pp. 120, 923; and *Bul. de la Soc. Bot. de France*, 38 (1891), pp. 176–184, 232–236, by L. Mangin; Annual Report of the State Botanist of the State of New York, 1891, C. H. Peck; Fossil Botany, being an Introduction to Palæophytology from the Standpoint of the Botanist, Oxford,

H. Solms-Laubach; *Monographie du Pourridie des Vignes et des Arbres fruitiers*, Montpellier, P. Viala; Croonian Lecture, On some Relations between Host and Parasite in Certain Epidemic Diseases of Plants, London, H. M. Ward; and Index to North American Mycological Literature (continued), by D. G. Fairchild (see p. 759 of this number of the Record.)

DIVISION OF ENTOMOLOGY.

INSECT LIFE, VOL. IV, NOS. 7 AND 8, APRIL, 1892 (pp. 231–292, figs. 13).—The principal contents of this double number are briefly summarized below:

Special notes (pp. 231–238).—These include reviews of Bulletin No. 33 of the New York Cornell Station, Wireworms; special Bulletin N of the New Jersey Stations, Insects Injurious to the Blackberry; Bulletin No. 85 of the New Jersey Stations, Farm Practice and Fertilizers to Control Insect Injury; and Bulletin No. 14 of the Oregon Station, A Plain Talk about Insects (see Experiment Station Record, vol. III, pp. 447, 705, 610, and 452); of articles on the cattle tick and on the ox warble, by C. Curtiss; of a brochure on the life history of the Hessian fly, by F. Enock; and of an article on Bacteria Normal to Digestive Organs of Hemiptera, by S. A. Forbes.

The potato tuber moth (pp. 239–242).—An account of *Lita solanella*, a Tineid moth, the larvæ of which bore into potatoes. It was first noticed in Tasmania in 1885 and has since been treated of by various Australian authors. It is very destructive to potatoes in Australia, Tasmania, New Zealand, and Algeria, and in November of 1891 it first attracted attention in California. As a remedy the immediate sequestration and destruction of all infested potatoes are advised.

A genus of Mantis egg parasites (pp. 242–245).—Notes accompanied by figures of *Podagrion mantis*, and of egg cases of *Stagmomantis carolina* and of an Australian mantid.

Notes on the grain Toxoptera, F. M. Webster (pp. 245–248).—Notes on the food habits, rapidity of reproduction, and prevalence of *Toxoptera graminum* in Indiana, from observations by the author.

The larger digger wasp, C. V. Riley (pp. 248–252).—A profusely illustrated article on the life history of *Sphecius speciosus*, with special references to its habit of storing its burrows with the common harvest fly (*Cicada pruinosa*) to serve as food for its larvæ.

The habits of Elasmus, L. O. Howard (pp. 253, 254).—A brief account of this Chalcidid genus and of the bred species and their hosts, with an illustration of *Elasmus varius*.

Bees of great value to fruit and seed growers, F. Benton (pp. 254–256).—Statements showing the value of bees in aiding in the distribution of pollen.

Some bred West Virginia Braconidæ, A. D. Hopkins (pp. 256–259).—A list of 33 species, with brief notes regarding host relations.

Notes on the habits of some California Coleoptera, D. W. Coquillett (pp. 260–262).—Brief notes on the following species: *Tritoma californica, Anthaxia æneogaster, Hydnocera scabra, Hedobia granosa, Vrilleta expansa, Sinoxylon declive, S. suturale, Amphicerus punctipennis, Psoa maculata, Lyctus striatus, Phymatodes juglandis, Xylotrechus nauticus, Ipochus fasciatus, Cassida texana, Phlœodes diabolicus, and Cœlocnemis californicus.*

Early published references to some of our injurious insects, F. M. Webster (pp. 262–265).—Accounts of some early references to various injurious insects in newspapers and elsewhere.

The color of a host and its relation to parasitism, C. W. Stiles and A. Hassall (pp. 265, 266).—A call for information from veterinarians, stock raisers, and farmers, with a view to determining whether white cattle are more subject to the attack of flies than dark-colored cattle and whether white flowls are more subject to the gapeworm disease than dark fowls, as stated by Wallace.

Extracts from correspondence (pp. 266–278).—Letters are published on the following subjects: The effects of a spider bite on a child; a maggot in peaches and scale insect (*Chinonaspis citri*) on the orange in Bermuda; insect injury to cocoanut palms; biological notes on Micracis, Chramesus, and Coscinoptera—three genera of Coleoptera; remedies for wireworms; the clover leaf beetle in western Pennsylvania; the rice weevil in dry hop yeast; how to kill tree borers with kerosene; note on the Carphoxera herbarium pest; treatment of the squash borer (*Melittia cucurbitæ*); Where are the eggs of the clover hay worm laid? the box elder bug attacking fruit in Washington State; notes, on the "blood-sucking cone-nose;" the orange leaf Aleyrodes; orange Chionaspis in Florida; on the treatment of human patients affected with screw worms; botfly larvæ burrowing under the skin of man; the horn fly in Mississippi; a southern cricket (*Gryllus* sp.) destructive to the strawberry; insanity caused by mosquito bites—hibernation of mosquitoes; death of an infant from a spider bite; on the poisonous bite of a spider, *Latrodectus mactans;* death due to the whip scorpion and tarantula; and tame birds as insect destroyers in greenhouses—the writer believes that certain insectivorous birds, like the wren, bluebird, and indigo bird, might be so thoroughly domesticated as to free our gardens and greenhouses of Aphides and other insect pests.

General notes (pp. 279–292).—A successful shipment of Vedalia from California to New Zealand is recorded. Reviews or notices are given of a recent publication on insect embryology, by Drs. Korshelt and Heider; of a catalogue of East India beetles; of recent publications on a European white grub fungus; of Bulletin No. 77*b* of the North Carolina Station, on arsenites and their effects on foliage (see Experiment Station Record, vol. III, p. 173); and of an article by C. M. Weed on the corn root aphis. Notes are also published on the injury to bees caused by spraying fruit, when in bloom, with arsenites; on the Colo-

rado potato beetle in Nova Scotia; on locusts in Egypt in 1891; and on spraying for the codling moth. The effectiveness of spraying has been illustrated by Mr. W. F. Brown, who carefully compared 100 unassorted apples taken from sprayed, and an equal number from unsprayed trees. From the sprayed tree 84 perfect apples were taken, 9 that were partially injured and 7 that were worthless, while the unsprayed tree yielded only 4 perfect apples, 58 injured, and 38 worthless ones. The titles of other notes presented are as follows: A remarkable butterfly enemy (*Hemisaga hastata*); the Angoumois grain moth; mosquito larvæ as supposed internal parasites; Lepidoptera whose females are wingless; tobacco insects in Florida; insect diseases of the Mediterranean orange; a new locality for *Icerya purchasi, i. e.* St. Helena; the use of vaseline and carbon bisulphide; a leaf miner in wheat (*Lachista præmaturella*); and an account of the beneficial insects recently sent by Mr. Koebele from Australia.

OFFICE OF EXPERIMENT STATIONS.

EXPERIMENT STATION BULLETIN NO. 7.

PROCEEDINGS OF THE FIFTH ANNUAL CONVENTION OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS, HELD AT WASHINGTON, D. C., AUGUST 12–18, 1891 (pp. 113).—This is edited by A. W. Harris for this Office and H. E. Alvord for the Association. Besides minutes of the general and sectional sessions, the papers read are given in full or by abstracts. For a brief account of the convention see Experiment Station Record, vol. III, p. 139. Papers on the following subjects were not mentioned in that report, but are published in the Proceedings: Soil Features that Should Be Recognized in All Plat Work, M. Whitney; Physical Conditions surrounding Animals in Experimental Feeding, Especially as Relative to Stalls and Mangers, W. A. Henry; The Number of Animals to be Used in Feeding Experiments, F. A. Gulley; Variety Testing in Cereals, How can it be Rendered more Decisive? J. F. Hickman; Manual Labor in Agricultural Colleges, W. F. Massey.

DIVISION OF STATISTICS.

REPORT NO. 94 (NEW SERIES), APRIL, 1892 (pp. 97–147).—This includes articles on the condition of winter grain, horses, cattle, sheep, and swine; speculation *vs.* industry; cotton acreage; European crop report for April; and rates of transportation companies. The condition of the grain crop is reported as low, the result of unfavorable conditions at time of planting and poor autumn growth rather than damage by winterkilling.

The live stock returns indicate remarkable immunity from serious disease among all classes of farm animals. The winter was generally favorable, feed abundant, and as a result, comparative condition is quite high. Losses from both disease and exposure have been light.

DIVISION OF CHEMISTRY.

BULLETIN NO. 13.

FOOD AND FOOD ADULTERANTS, PART VI, H. W. WILEY (pp. 242).—This part treats of the adulteration, adulterants, and methods of recognizing them, of sugar, molasses and sirup, confections, honey, and beeswax. The investigations were made with the collaboration of chemists in various parts of the United States. Each chemist was requested to purchase in the open market and analyze 50 samples each of molasses, liquid honey, and low-grade sugars, and 25 samples of cheap confections. The report is largely comprised of the results of these analyses, discussion of the methods employed, the adulterants used, remarks on the extent of the adulteration of the articles mentioned, etc. In addition to this, a list is given of patents relating to the manufacture of artificial comb foundation, and bibliographies of honey, beeswax, and waxes used in adulterating beeswax.

Some of the general results of the investigation are stated in the following paragraphs taken from the report:

Sugar.—The total absence of any added matter to the sugars of commerce is plainly shown by the 500 analyses of samples purchased in open market in different parts of the country. * * *

Molasses and sirup.—For the purposes of this report a molasses or sirup is adulterated whenever it contains glucose or any other substance which would not be a natural product of sorghum, sugar cane, or the maple tree. Molasses or sirups which are made exclusively of the products of sorghum, sugar cane, and maple sap can not be said to be adulterated in the strict sense of the term, no matter what the method of their preparation may be. * * *

[It was found that glucose is largely used as an adulterant of molasses and sirups.] It gives to a sirup a fine body and a light color. A molasses or sirup, therefore, made chiefly of glucose and flavored with the refuse molasses of a refinery, makes a very attractive article for table use, in so far as appearance goes. In regard to wholesomeness also it is not possible to condemn glucose. When properly made it is apparently as wholesome an article of diet as cane sugar. * * *

It has long been known that a large part of the maple sirup sold in the market is made from glucose, understanding by this term the liquid product of the conversion of starch into sugar. It is also well known that large quantities of maple sirups are sold on the market which are fabrications made up of other sweets, to which a little maple molasses is added for the purpose of giving it flavor, or, as is often the case, are entirely free from any addition of maple product whatever. The maple flavor is imparted to sirups by mixing with them an extract of hickory bark, and this product has been made and sold under the term of "mapleine." It is safe to say that perhaps the greater quantity of maple molasses or sirup sold on the market is an adulteration in the true sense of the word. * * *

Confections, general summary.

Total number of samples examined	250
Contained glucose	173
Contained starch and gum	72
Contained organic colors	218
Contained mineral colors	2
Contained grease	14
Contained copper	4
Contained gelatin	2

In so far as the coloring matter was examined, the following table shows the character of the pigments used and the relative number of times they were found:

	Samples.		Samples.		Samples.
Cochineal	14	Ultramarine	3	Lampblack	1
Eosin	12	Turmeric	2	Victoria yellow	1
Corallin	6	Methyl orange	2	Magenta	1
Bengal red	5	Coal tar colors	2	Orange red	1
Fluoresceïn	3	Carmine	2	Aniline brown	1
Fluorescent color	3	Cyanin	1	Bismarck brown	1

In connection with the coloring matters, however, it should be remembered that in the great majority of cases no attempt was made to distinguish them further than to determine whether they were of an organic or inorganic nature. Only one analyst (Weber) determined the nature of the coloring matter in each instance. Two of the number (Stubbs and Wallace) did not report the number of samples colored. In the general summary this number was taken at 20 in each case.

The following substances were found in the 250 samples submitted to examination:

(1) Sucrose.
(2) Dextrose.
(3) Maltose.
(4) Dextrin.
(5) Starch.
(6) Soluble starch.
(7) Gum.
(8) Gelatin.
(9) Grease.
(10) Flour.
(11) Copper.
(12) Mineral colors.
(13) Citric acid.
(14) Tartaric acid
(15) Peppermint.
(16) Horehound.
(17) Musk.
(18) Marsh mallow.
(19) Raspberry flavor.
(20) Vanilla.
(21) Pistachio.
(22) Almonds.
(23) Apricot.
(24) Strawberry.
(25) Oil of wintergreen.
(26) Banana flavor.
(27) Lemon flavor.
(28) Cinnamon.
(29) Cloves.
(30) Cocoanut.
(31) Cochineal.
(32) Eosin.
(33) Corallin.
(34) Bengal red.
(35) Fluorsceïn.
(36) Fluorescent color.
(37) Ultramarine.
(38) Turmeric.
(39) Methyl orange.
(40) Coal tar colors.
(41) Carmine.
(42) Cyanin.
(43) Lampblack.
(44) Victoria yellow.
(45) Magenta.
(46) Orange red.
(47) Aniline brown.
(48) Bismarck brown.

The above list does not by any means pretend to be a complete catalogue of the materials found in the confections of commerce. It represents only the substances incidentally found in the 250 samples purchased in open market to supply the material for the examinations made.

Honey.—The samples of honey described in the report were liquid or strained honey or comb honey packed in glass jars. The examination did not extend to comb honey in frames.

Perhaps there is no article of food which has been so generally adulterated in the United States during the last 20 years as honey. The ease with which sophistication could be practiced, the cheapness of the material used, and the high price of the genuine product have presented temptations which the manufacturer, producer, and dealer have not been able to withstand.

DIVISION OF CHEMISTRY.

BULLETIN NO. 32.

SPECIAL REPORT ON THE EXTENT AND CHARACTER OF FOOD ADULTERATIONS, A. J. WEDDERBURN (pp. 174).—This is a popular summary of information, similar in character to that published in Bulletin

No. 25 of the Division of Chemistry. It includes general statements regarding the extent and character of food adulterations; the opinion of State officials and others regarding the need of national legislation on this subject; statements regarding the substances used as adulterants of foods, beverages, drugs, and manufactured articles; the text of State and other laws relating to foods and beverages; and a list of State officers who are charged with food inspection.

That adulteration exists to a most alarming extent can not, from the evidence, be doubted; that the character is generally fraudulent rather than dangerous seems to be also pretty well established. * * *

Wholesome laws have succeeded in checking the commercial frauds, but it is generally conceded by all State officers engaged in the work that until national legislation supplements State laws, all such enactments will prove insufficient and unsatisfactory. The report from London shows that the anti-adulteration laws of Great Britain have almost entirely stopped the nefarious practice. The laws of New York, New Jersey, and Massachusetts, which have been fairly well enforced, have done much towards stopping the practice, or at least compelling the proper branding of the articles sold. * * *

While commercial frauds are the rule, there are, as is proven, many cases where ill health and even death follow the use of articles poisoned with pigments, acids, tin, rancid oils, and other injurious commodities which are used to cheapen or add beauty to the article sold.

Polishing, powdering, watering, and adding such harmless ingredients as earth, cracker dust, peas, beans, starch, etc., are comparatively harmless, and would pass for honesty and uprightness when compared with the compositions above alluded to, and others, such as plaster of Paris, soapstone, fusel oil, red ocher, fuller's earth, terra alba, and other ingredients of like character; but even these are less harmful than the adulterations of drugs, by which, as is shown, the very element of strength, upon which the physician relies to save life, is often extracted, left out, or diluted until it becomes a matter of grave doubt whether a prescription really contains what is ordered by the physician. * * *

No reason exists for a change of the views expressed in Bulletin No. 25 as to the cost to the country of fraudulent adulterations, and while those figures have been attacked in certain quarters, still it is undoubtedly safe to estimate that at least 15 per cent of the entire food product is adulterated in one form or another, the overwhelming proportion of which is sold under fraudulent brands.

Recent State laws are gradually rectifying this evil, but as long as the article is branded "pure" when it is "compounded," just so long is the deception a fraud and the purchaser swindled. * * *

All correspondents who have touched upon the subject unite in the opinion that the demand for national inspection is general and absolutely necessary. * * * Reputable merchants and manufacturers unite in urging general legislation backed by the State officials, most of whom in their reports complain of the lack of national laws and of inefficient laws or want of laws in adjoining States, which makes the enforcement of local laws much harder work, and in certain cases makes the law almost a dead letter.

Such laws as are enforced are giving such general satisfaction to consumers and to honest dealers that we find each year more rigid enforcement of the statutes, and that the field is gradually widening and additional territory is being covered, while in those States which have for the longest period been regulating the food supply we find amendments which greatly aid the inspectors in the performance of their work. All that is now lacking seems to be the enactment of a Federal law governing the interstate commerce question, and misbranding (which is the greatest evil) will at no distant day become so rare that here, as in England, the fraudulent dealer will have ceased to ply his vocation to any injurious extent.

WEATHER BUREAU.

MONTHLY WEATHER REVIEW, VOL. XIX, NOS. 11 AND 12, NOVEMBER AND DECEMBER, 1891, AND VOL. XX, NO. 1, JANUARY, 1892 (pp. 259–287, charts 7; pp. 289–318, charts 6; pp. 31, charts 7).—Besides the data on the topics reguarly treated in this publication, the January number contains an article on Chinook winds, by E. B. Garriott.

INSTRUCTIONS FOR VOLUNTARY OBSERVERS, T. RUSSELL (pp. 100, figs. 21).—Revised and enlarged instructions, including illustrated descriptions of instruments, directions for their use, and tables for calculating observations.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

A new method of organic analysis, Berthelot (*Compt. rend., 114 (1892), p. 317*).—This method consists in burning the substance in a calorimetric bomb in oxygen under a pressure of 25 atmospheres. The combustion is complete and instantaneous, contrasting with that which occurs in combustion with oxide of copper. The operation is performed in a calorimeter, following the ordinary method of determining heats of combustion, but is independent of the calorimetric determination. As soon as the combustion is complete the gas in the bomb is allowed to pass through the usual system of tubes used in organic analysis—the desiccating tubes of pumice stone saturated with sulphuric acid, and those containing liquid and solid potash. This done the residual gas of the bomb is drawn out by means of a mercury pump and made to pass through the same absorbing apparatus; purified air is then allowed to enter the bomb. This operation is repeated two or three times in order to remove all the carbonic acid. The determination of carbon is in this manner made very quickly and with absolute precision.

The determination of hydrogen is a little more complicated; it may be accomplished, however, by using dry oxygen and heating the bomb slightly after the operation for the purpose of vaporizing all the water which results from the preceding operation. Account must be taken, however, of traces of nitric acid produced during the combustion, which are driven off with the water. The simple determination of carbonic acid is not subject to this complication; the water which condenses in the bomb retains all traces of nitric acid.

The combustion in the bomb also permits of the determination of sulphur in organic substances, if 10 c. c. of water be added before the operation commences. The sulphur is found in the water in the form of free sulphuric acid, as has been demonstrated by very careful tests. This is the quickest method which exists for the determination of sulphur and is equally applicable to the determination of phosphorus in organic substances.

The formation and behavior of basic calcium phosphate and its relation to Thomas slag, O. Förster (*Zeitsch. f. angew. Chem., 1892, pp. 13–22; abs. in Chem. Centralbl. 1892*, I, *p. 273*).—The investigations of the author lead him to the following conclusions: Thomas slag contains

as active constituent, tetracalcic phosphate, $P_2O_8Ca_3.CaO$, which is soluble in magnesium citrate solution. This tetracalcium salt changes readily to dicalcic phosphate, and this, with a part of the calcium set free, forms the compound $(Ca_3P_2O_8)_3Ca(OH)_2$, in which the calcium hydroxide is chemically bound, as no lime is dissolved from it by sugar solution. This last compound is soluble in citric acid, but the compound $(Ca_3P_2O_8)_3CaO$, which comes from it, is nearly insoluble. This $(Ca_3P_2O_8)_3CaO$ is formed by heating tricalcic phosphate and lime at medium heat. At the temperature at which wrought iron softens tetracalcium phosphate is always formed. If the tetra salt is heated for a long time at a low temperature it breaks up into CaO and $(Ca_3P_2O_8)_3CaO$, which, as mentioned above, is insoluble in citric acid. It is suggested that the presence of insoluble phosphates in Thomas slag in connection with the soluble tetracalcium phosphate is not necessarily due to insufficient lime or to adulteration, but may be due rather to too slow cooling of the slag or inopportune admission of air, whereby a part of the tetracalcium phosphate was changed to the insoluble $(Ca_3P_2O_8)_3CaO$.

A sensitive reagent for albumen in urine, E. Spiegler (*Ber. d. deut. chem. Ges., 25 (1892), pp. 375–378*).—The author describes a new reagent by which traces of albumen can be recognized so small that the potassium ferrocyanide reaction either gives no indication or is uncertain. The reagent consists of a solution of 8 parts of corrosive sublimate, 4 parts of tartaric acid, and 20 parts of cane sugar in 200 parts of water. The urine to be tested is acidulated with a little concentrated acetic acid to precipitate the mucin, decompose any carbonates present, and free the phosphoric acid of the alkaline phosphates; filtered if necessary; and then by means of a pipette slowly added to the reagent by allowing the drops to run down the side of the test tube in such a manner that the two liquids are not mixed but form two layers. The reagent is purposely made of a high specific gravity to prevent mixing. If albumen is present a distinct whitish ring is formed at once where the two layers meet, which is especially sharp if the tube is held before a dark background. A special advantage of the reaction is that urine which has been acted upon by bacteria can be tested directly without first clarifying. If albumen is present the ring which is formed is easily distinguished from the cloudiness caused by the bacteria.

It is said that 1 part of albumen in 150,000 can readily be detected by the reaction, and if the tube is allowed to stand quietly for about a minute after adding the reagent a plainly perceptible ring appears with 1 part to 225,000, while the limit to the sensitiveness of the potassium ferrocyanide reaction is given as 1 to 50,000.

Fungicides and insecticides, J. H. Panton (*Ontario Agr. College Expt. Station Bul. No. 73, April 8, 1892, pp. 6*).—Formulas for a number of the more common fungicides and insecticides, with brief directions for their application.

Third annual report of the Halle Station for experiments in the repression of nematodes, 1891. M. Hollrung (pp. 35).—The greater part of this Report is given up to an account of experiments in destroying the beet nematode *Heterodera schachtii*. It has been generally supposed that the condition of the soil known as beet sickness (*Rübenmüdigkeit*) was due to or was at least favored by continuous cropping with beets, but the author mentions several cases in which this trouble occurred in fields planted with sugar beets for the first time. On examination the trouble was found to be due in every case to the beet root nematode. The author is unable to explain this sudden appearance of the parasites, but is not inclined to believe that the worms or their larvæ were introduced with the seeds or transported by the wind.

Details are given of six field experiments carried out by beet growers under the direction of the station on some 75 acres with Kühn's method for destroying the parasites by the use of bait plants (*Fangpflanzen*). Owing probably to a failure to carry out directions, only two of these experiments were successful. The history of the most successful experiment is as follows: In 1883 a plat of nearly 8 acres (12.5 *Morgen*) was planted with seed beets, which were ruined by nematodes; in 1884 rye was planted; in 1886 bearded wheat; in 1887 potatoes; in 1888 barley; in 1889 an attempt was made to clear the field of nematodes by using bait plants, which were allowed to grow until infested with the worms and were then destroyed together with the parasites; in 1890 summer wheat was planted; in 1891 sugar beets. The beets were fertilized with Chile saltpeter and superphosphate; they grew well during the entire season, polarized 16 per cent of sugar, and gave a crop of nearly 16 tons per acre.

In the other successful experiment the field treated with bait plants produced about 15 tons per acre, while a neighboring field which had not been baited produced less than 6 tons per acre.

A case is cited (*Wiener landw. Ztg., 1891, No. 28*) where a field which yielded 6 tons per acre before the use of the bait method, produced nearly 18 tons per acre after that method had been tried.

As beets can not be planted the year the bait plants are used, experiments were tried in which the infested fields were first planted with bait plants and afterwards with early potatoes in order that the ground should not remain idle the entire year. The results of experiments on five different farms and with different varieties of early potatoes are tabulated and discussed. The returns were such as to pay the entire expenses of the experiments and leave a considerable margin of profit. The author believes that in further trials this method will prove still more successful. The general conclusions drawn from the five experiments of this nature are: (1) The first bait should be planted April 10–15; (2) it is more important that the potatoes should be hardy than that they should be early; (3) 8 to 10 days should elapse between the time the potatoes are planted and the second bait is destroyed.

From investigations on the disease known as "beet consumption" (*Rübenschwindsucht*), the author concludes that (1) it is due to a local and very injurious form of beet nematodes; (2) it can be entirely checked by destroying the nematodes; (3) it can be partially checked by the liberal use of fertilizers. Experiments to determine the effects of various fertilizers upon the worms led to the conclusion that lime is more effective than kainit.

From experiments with diffusion residue at beet sugar factories the author concludes that residue which has been subjected to the action of limewater with an alkalinity of 0.13 per cent, is completely free from the nematodes, and that 0.05 per cent alkalinity is probably high enough to kill the worms.

Besides *Heterodera schachtii* several other enemies of the sugar beet of less importance are briefly mentioned.

Field trials with barnyard manure preserved with superphosphate gypsum, J. R. Schiffer (*Zeitsch. d. landw. Ver. f. Rheinpreussen, 1892, pp. 43, 44*).—These trials were made to observe the practical results of preserving barnyard manure with superphosphate gypsum, as shown by the yield of potatoes and barley fertilized with preserved and unpreserved manure. The superphosphate gypsum used contained 65 per cent of gypsum; 12.6 per cent of soluble phosphoric acid, 8 per cent of which was in the form of free acid; and 2 per cent of inverted and 0.5 per cent of insoluble phosphoric acid. A chemical test indicated that 100 pounds of it was capable of retaining 11.4 pounds of nitrogen. When used it was sprinkled over the manure in the stable every day. The manure was a mixture from cattle, horses, and hogs. For a time no superphosphate gypsum was added, but later, while the same rations were being used, 1 pound was added each day to the manure produced by one horse or cow, and 0.2 pound to that produced by a pig. Plats on three different kinds of soil were manured with the preserved and unpreserved manure. The unpreserved manure was spread on the land earlier in the spring, which gave it some advantage over the other. The average yields of barley and potatoes per acre are given as follows:

	Potatoes.	Barley.
With preserved manure	247 bushels.	42.1 bushels.
With unpreserved manure	232 bushels.	34.5 bushels.
Difference	15 bushels.	7.6 bushels.

The potatoes where the treated manure was used averaged 21.6 per cent of starch, and those where the other was used 17.91 per cent. The author calculates a net increase from the use of preserved manure over the unpreserved of about $35 per acre in the trial with potatoes. These results are for the first year after the application of the manure.

Coöperative field experiments with barley, C. von Eckenbrecher (*Sächs. landw. Zeitsch., 1892, pp. 138–142*).—These were of the nature of variety tests, but were made to test the applicability not only of

these varieties, but of barley culture in general, to certain sections of Germany. They were made on twelve representative farms. The varieties tested were Richardson Chevalier, v. Trotha Chevalier, Heine Improved Chevalier, and Kwassitzer Original Hanna Pedigree barley. Great care was taken to procure seed of high brewing qualities, and the barley raised was graded by three experts on the basis of its value for this purpose.

While the results for the single year's test are not regarded as final, they are interesting as showing that in many sections of the country previously regarded as unfit for the growth of barley, a good quality for malting can be raised. The Hanna barley gave exceptionally good results in all cases, even where other varieties were partial failures.

Composition of light and heavy oats, R. Heinrich (*Landw. Ann. d. meck. pat. Vereins, 1892, pp. 47–49*).—Two samples each of light and heavy oats were examined. The first set of these (No. 1) were sent to the station, and nothing is known of the conditions under which they were grown. Their relative weights were:

	Heavy oats.	Light oats.
Weight per bushel	30.2 pounds.	23.6 pounds.
Weight of 1,000 grains	38.1 grams.	26.7 grams.
Relation of naked kernel to inner glumes	100 : 36	100 : 50

The second set of samples (No. 2) were grown at the Rostock Experiment Station, on a light soil deficient in nitrogen. They followed a crop of serradella. The heavy oats had received a dressing of nitrate of soda; the light oats were unmanured, but were grown on an adjoining plat. The weights were:

	Heavy oats.	Light oats.
Weight per bushel	33.3 pounds.	27.5 pounds.
Weight of 1,000 grains	31.48 grams.	28.98 grams.
Relation of naked kernel to inner glumes	100 : 44	100 : 53

The composition of the light and heavy oats was found to be, as follows:

Analyses of light and heavy oats.

	No. 1.				No. 2.			
	Air-dry.		In dry matter.		Air dry.		In dry matter.	
	Heavy.	Light.	Heavy.	Light.	Heavy.	Light.	Heavy.	Light.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Water	14.7	13.8	....	....	11.1	10.8	....	....
Protein	10.1	9.2	11.8	11.7	9.2	9.4	10.4	10.5
Fat	4.7	5.5	5.55	6.4	5.0	4.7	5.6	5.3
Carbohydrates	58.0	56.8	67.95	65.8	62.0	58.7	69.7	65.8
Cellulose	9.8	11.3	11.5	13.1	10.3	13.6	11.6	15.3
Ash	2.7	3.4	3.2	4.0	2.4	2.8	2.7	3.1
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

While there were no very marked differences in composition between the light and heavy grain, in general the light oats contained somewhat less carbohydrates and more cellulose than the heavy. The

protein content was practically the same for the two weights. It will be seen that a light weight per bushel was always accompanied by a light weight per 1,000 kernels, and that the proportion of glumes in the seed was highest in the case of the light oats. In the light oats the glumes were more fully developed than the kernel, the reason for which is plain when the order of development of the parts is considered. As the glumes are formed much earlier than the kernel, the final development of the kernel might be hindered by drouth and other causes after the glumes were fully formed, in which case the percentage of glumes would be larger than in normally ripened grain. The protein content of the naked kernels and the inner glumes was determined in the oats grown at the station, with the following result (in air-dry material):

	Naked kernel.	Inner glumes.
Heavy oats	12.3 per cent.	2.0 per cent.
Light oats	13.1 per cent.	2.1 per cent.

While, therefore, a measured quantity of the light oats contains a less amount of food nutrients than the heavy oats, pound for pound the two are about equal.

Examination of wheat of different years, W. Windisch (*Wochensch. f. Brauerei* (9), *1892, p. 220; abs. in Chem. Ztg., 1892, rep. p. 95*).—Ten samples of wheat grown in 1891 were examined as to their value for brewing, and the results compared with crops of 1889 and 1890, with the following results:

Wheat of 1889, 1890, and 1891.

Crop of—	Water content.		Protein in dry matter.		Character of endosperm.		
	Range.	Average.	Range.	Average.	Flinty.	Half flinty.	Mealy.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1889	11.42–17.03	14.1	11.86–13.55	12.7	12	28	60
1890	12.04–16.87	13.2	10.75–13.94	11.2	6	20	74
1891	14.25–16.42	15.1	13.09–15.04	14.1	17	74	9

The 1891 wheat contained more water and more protein in dry matter than that from either of the 2 previous years; the character of the endosperm was inferior.

On the assimilation of carbohydrates, Hanriot (*Compt. rend., 114* (*1892*), *pp. 371–374*).—Pflüger has designated as coefficient of respiration (*quotient respiratoire*) the relation between carbonic acid given off in a given time and oxygen absorbed in the same time. The coefficient for a man fasting is less than unity, as may be readily seen, for if we examine the formulas of the fats and albuminoid substances, we will find that they contain less oxygen and nitrogen than is necessary for transforming their hydrogen into water and ammonia; the oxygen absorbed in respiration is used, therefore, to burn the excess of hydrogen and all of

the carbon of the food. If the carbonic acid contains its proper amount of oxygen, the amount of oxygen absorbed must exceed that returned in the carbonic acid.

The carbohydrates—glucose, starch, etc.—contain the exact amount of oxygen necessary for converting all of their hydrogen into water; their combustion, therefore, produces a volume of carbonic acid equal to that of the oxygen employed; in fact those who have investigated the coefficient of respiration have observed that during the digestion of starchy substances the ratio increases and tends toward unity. In experiments reported by the author and C. Richet in *Compt rend.*, 1887 and 1888, it was observed that this ratio was sometimes greater than unity, indicating that it was not due to a simple combustion of the carbohydrates. More recently the author has carefully investigated the conditions giving rise to the high ratio thus incidentally observed. It was found that the coefficient of respiration exceeded unity in every case where a person fasting was given carbohydrates diluted with a large quantity of water. When a small quantity of glucose (50 grams) dissolved in 1 liter of water was used, the ratio observed in each experiment was approximately 1.25. The oxygen contained in the carbonic acid exhaled was greater than the oxygen absorbed in respiration, and it seems evident that the excess is furnished by the carbohydrates themselves, which break up in the organism into carbonic acid and other substances less rich in oxygen. The breaking up is produced in the intestines by a true butyric acid fermentation or otherwise. It has been observed by the author and C. Richet that carbonic acid introduced into the intestines was rapidly absorbed and eliminated in respiration. To remove this factor the author studied the quotient of respiration in a person in whom intestinal fermentation was arrested by continued use of naphthol.

Subject after fasting 3 hours .... $\frac{CO_2}{O_2} = 0.84$

Subject after eating 820 grams of potatoes .... $\frac{CO_2}{O_2} = 0.984$

The same person afterwards took every 2 hours a dose of 0.5 gram of pure β-napthol; he also took a supplementary dose at each meal. Nineteen hours after the first dose, after a fast of 6 hours, his coefficient of respiration was 0.85; after a meal composed of potatoes 820 grams, water 30 grams, and salt 30 grams the coefficient was 0.986. Forty-four hours after the first dose, while fasting, $\frac{CO_2}{O_2} = 0.74$. Two hours after, a meal composed of 13 kg. of potatoes in soup and 500 grams of water, $\frac{CO_2}{O_2} = 1.08$. At the end of 69 hours from the first dose (having taken 35 grams of naphthol), while fasting, $\frac{CO_2}{O_2} = 0.8$; after absorption of glucose, $\frac{CO_2}{O_2} = 1.10$. The influence of napthol on the evolution of carbonic acid was not apparent, which goes to show that this evolution is

not due to an intestinal fermentation, but to a transformation in the organism.

The earlier experiments of Boussingault, Persoz, and others having demonstrated that the animal may store up more fat than is furnished in their food, the author accounts for the fact by supposing that glucose is converted into fat in the organism according to the following equation:

$$13C_6H_{12}O_6 = C_{55}H_{104}O_6 + 23CO_2 + 26H_2O$$

$C_{55}H_{104}O_6$ represents oleo-stearo-palmatin, which is taken as the average composition of the fats. If we substitute tripalmatin or trimargarin we arrive at figures almost identical. The equation shows that 100 grams of glucose in being transformed into fat evolves 21.8 liters of carbonic acid. The author determined the respiration coefficient of a person fasting, then gave him a known quantity of glucose dissolved in a large quantity of water and measured the amount of carbonic acid exhaled and the oxygen absorbed during the time required for the respiration coefficient to fall to what it was at the beginning of the experiment. He calculated the amount of carbonic acid corresponding to the oxygen absorbed, and the difference between carbonic acid found and that calculated corresponded to the transformation of glucose into fat as given by the above equation. The results of the experiments were as follows:

$\frac{CO_2}{O_2}$ At the beginning.	Quantity of glucose.	Duration of experiment.	Total volume. O_2	Total volume. CO_2	Excess of CO_2 Found.	Excess of CO_2 Calculated.
	Grams.	*Hr.*	*Liters.*	*Liters.*	*Liters.*	*Liters.*
0.82	48	4.30	60.05	58.85	9.65	10.46
0.86	73	4.40	74.25	79.90	16.15	15.94
0.83	23	4.10	59.40	54.95	5.65	5.01

The excess of carbonic acid found approximates the theoretical amount as closely as might be expected in the different experiments. The length of time required for the transformation of the glucose was almost the same whatever the amount of glucose absorbed. Variations were confined to the respiration coefficient, which was raised to 1.3 by an absorption of 350 grams of glucose. It was found best, however, to use an amount of glucose not exceeding 75 grams.

It appears then that the glucose introduced into the organism does not simply undergo combustion or transformation into glycogen, but is converted quantitatively into fat.

In another communication in the near future the author proposes to submit additional data in confirmation of this proposition.

Contribution to the knowledge of sumac, W. Eitner (*Der Gerber 18 (1892), p. 51; abs. in Chem. Ztg., 1892, rep. p. 95*).—Reference is made to the investigations of Macagno which showed that the tannin in sumac leaves varies during the season, rising to a maximum and then gradually diminishing as the season advances. Macagno is quoted

as having found that Virginia sumac which contained 21 per cent of tannin in the leaves in June contained only 15 per cent in August. The author made similar studies on the Bosnian sumac with similar results, as will be evident from the following:

Tannin in leaves gathered—	Per cent.
June 23	18.97
July 7	22.97
July 21	18.89
August 4	17.17
August 18	17.30
September 2	16.83

The leaves in this case contained the maximum quantity of tannin before blooming and at a time when they were generally fully developed.

In Sicily the leaves are harvested in three periods: The lower leaves are gathered by the end of May; then, proceeding upwards, the leaves are removed as fast as they are fully developed. In this way a product is secured containing as high as 26 per cent of tannin. American sumac is said to reach the maximum content of 27 per cent in July; but as most of the gathering is not done until considerably later, usually before the leaves dry up or frost comes, the product in the market is said to be much lower than this in tannin.

Gathering at the time of the maximum tannin content has the further advantage that the product can then be used in making white leather, while the fully ripened or overripe leaves contain a yellowish brown active coloring matter which unfits them for this purpose. This coloring matter appears in large quantities in the leaves towards the close of the growing season. It is also rapidly formed in young leaves which are exposed to the sunlight while in a wilted state, that is before being thoroughly dried, or when they are stored in a moist condition. In the first case they also suffer a loss of tannin; in the last they do not unless they mildew, when the tannin diminishes rapidly and the material becomes musty.

[It was pointed out by this Department in earlier publications that "the cause of the difference in price in favor of the Sicilian product is due to the coloring matter contained in American sumac, which prevents the employment of the latter in the manufacture of white leather." If it is true, as stated above, that the presence of this coloring matter may be avoided by harvesting earlier and by proper care in drying and storing, the cause of the lower price would seem to be remediable.]

Contribution to the solution of the nitrogen question, H. Immendorff (*Landw. Jahrb., 21 (1892), pp. 281–339*).—The author prefaces the report of his own experiments by an historical review of the whole subject, but more especially that part referring to processes taking place in soils and in manures by which combined nitrogen is set free and the uncombined nitrogen of the atmosphere is fixed.

Like many other changes in organic substances, these processes are to-day attributed directly or indirectly to the physiological action of microörganisms. He reviews the work of Frankland, Warington, and Winogradsky, which leads to the conclusion that nitrification is principally a physiological and not a purely chemical process. With regard to the freeing of nitrogen in the processes of decay and putrefaction, he briefly reviews the more recent work as follows:

The experiments of J. Reiset and others lead to the general belief that in the processes of decay, whether under exclusion or by free access of air, the combined nitrogen is changed to the elementary form. But it is believed there are no chemical grounds for supposing that in addition to ammonia free nitrogen also escapes when nitrogenous organic material containing no nitrates or nitrites is allowed to decay under exclusion of oxygen. In exact experiments by Kellner,* Tacke,† and Ehrenberg,‡ these authors were not able to discover any generation of free nitrogen in the decay of nitrogenous organic matter, whether in the presence of or under exclusion of oxygen. This result was further verified by Schlösing§ in investigations on the marsh-gas fermentation in barnyard manure. The case is different where nitrates or nitrites are contained in or formed in the decaying material, for experiments have shown that they suffer an energetic reduction. Tacke found that in all decay in the presence of nitrates the latter were reduced under formation of free nitrogen and all of the intermediate stages of oxidation (N_2O, NO, and N_2O_3). The relation of these products of reduction to one another showed wide variations, depending largely on a number of circumstances. In Tacke's‖ experiments the decaying material was not well ventilated, and the author believes it possible that in the presence of sufficient oxygen the reduction might be altogether avoided.

Leone** studied the reduction of nitrates and nitrites by microörganisms and sought to determine whether nitrates could be changed to ammonia in the reduction. The results of his trials led him to believe that the nitrogen of the nitrates is not assimilated by microörganisms and is not changed to ammonia; only the oxygen of the nitrate and nitrite is of importance to the life of these organisms. In a series of experiments he was able to collect approximately the calculated amount of nitrogen which was contained in the nitrate of soda employed. His experiment indicated how extensive may be the generation of elementary nitrogen in the reduction of nitrogen acids by microörganisms.

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* Zeitsch. f. physiol. Chem., 12 (1887), p. 95.

† Landw. Jahrb., 16 (1887), p. 917.

‡ Zeitsch. f. physiol. Chem., 11 (1887), pp. 145, 438.

§ Compt. rend., 109 (1889), p. 835; Experiment Station Record, vol. III, p. 736.

‖ Loc. cit.

** Abs. in Centralbl. f. agr. Chem., 1890, p. 283.

The process by which the loss of nitrogen may be prevented, that of nitrification of ammonia, takes place, as is well known, extensively in nearly all soils, and frequently in the storing of barnyard manure when the ventilation is sufficient. In the latter case the nitrification is believed to be of no advantage, since reduction, the result of which has been referred to above, is also going on in the fermenting mass. The author refers to experiments bearing on the question of the loss of free nitrogen in the processes of nitrification. Dehérain* and Tacke† both observed a loss of nitrogen in the nitrification of soils. Ehrenberg,‡ on the contrary, was unable to note any loss of nitrogen, but in his experiments the ventilation is said to have been incomplete. Schlösing's§ experiments lead him to conclude that there is not necessarily a loss of nitrogen in nitrification, even when the latter is very energetic. This lack of uniformity in the results obtained by different persons the author is unable to account for, but more will be said upon this subject in the discussion of his experiments further on.

The subject of the enrichment of soils in nitrogenous compounds at the expense of the free nitrogen of the atmosphere is carefully reviewed in all its bearings.

The author then reports experiments by himself which were made to study the liberation of nitrogen in the decomposition of organic nitrogenous material in well-ventilated soil. The experiments were made to settle the much-disputed question, whether or not an escape of free nitrogen accompanies nitrification. They were carried on in a closed apparatus from which the air was excluded and which was placed in an oven at 28°–32° C. The apparatus was filled with a mixture of oxygen and hydrogen in the proportion to form water, which was supplied by electric generators within the apparatus. Prior to the experiment the air in the apparatus was thoroughly expelled by the gas mixture, and at intervals during the progress of the experiment samples of the gases were taken for analysis. Two sets of apparatus were used. The first contained 14.856 grams of a mixture of 10 parts of ground blood, 50 parts of garden soil, and 10 parts of calcium carbonate, the last being introduced to present the most favorable conditions for nitrification. The second apparatus contained 14.3969 grams of a mixture of 30 parts of bone meal, 40 parts of soil, and 12 parts of calcium carbonate. The experiments were commenced about the middle of March and continued to the first of June. The results showed that in the first week, while an energetic ammonia fermentation was going on, there was either no free nitrogen liberated or only mere traces. Later, during the course of the saltpeter formation, it is believed the losses of free nitrogen were relatively large. The amount of nitrogen liberated in the first experiment was 16 c. c.=20 mg., and in the second 9 c. c.=11 mg.

* Ann. Agron., 13 (1887), p. 241.

† Landw. Jahrb., 18 (1889), p. 439.

‡ Zeitsch. f. physiol. Chem., 11 (1887), p. 145.

§ Comp. rend., 108 (1889), p. 205, and 109, p. 423.

The author believes the loss of nitrogen may be attributed to the process of nitrification. In no case was N_2O found, although nitric acid occurred in considerable quantities. The author thinks it is therefore safe to conclude that in the oxidation of ammonia to nitric acid in the soil under natural conditions loss of nitrogen through the formation of N_2O does not take place, provided, of course, that after the formation of nitric acid no reduction takes place by which all of the lower oxidation products of nitrogen might be formed.

In the next series of experiments the loss of nitrogen through the decomposition of organic nitrogenous material was determined indirectly by means of the difference method. These experiments embraced three series, in all of which the material was ventilated with air which had been thoroughly washed to free it of ammonia and nitrogen acids. The apparatus was made all in one piece to exclude the possibility of any nitrogen compounds entering at the joints. The total nitrogen was determined in the material taken at the beginning and close of each experiment, and provision was made for collecting all nitrogen compounds generated in the meantime. No addition of nitrogenous compounds was made to the soils used, although a small amount of calcium carbonate was added. The soils were partly from the experimental fields of Poppelsdorf and partly from the Schultz-Lupitz lupine soil. Altogether six such experiments were made, two of which were with sterilized soil. They lasted about 340 days. In no case was there an increase of combined nitrogen, but on the contrary there was a loss in every experiment except the two with sterilized soil, in which case the amount remained practically unchanged. This is a further indication that by the simple chemical action of the oxygen of the air without the activity of bacteria, which in these experiments lasted nearly a year, there is scarcely any danger of a loss of nitrogen from the oxidation of the nitrogenous substances. In the next series of experiments ammonium sulphate and ground bone were each mixed with soils, and ground bone and ground blood were both used without soils, receiving additions of calcium carbonate in some cases and in others none. Where soils were used a very slight loss of nitrogen accompanied nitrification. In the other experiments no nitric or nitrous acids were formed and no nitrification was detected, but considerable ammonia was given off. There was a gain in nitrogen in the latter cases, indicating that here materials comparatively rich in nitrogen and in which decomposition was far advanced had fixed nitrogen from the air. Berthelot ascribes this fixation only to soils poor in nitrogen, but these as well as earlier experiments by Tacke seem to show that it may also be effected by materials rich in nitrogen.

The object of the fourth series of experiments was to study the retention of nitrogen by certain materials. Ground horn was mixed in separate cases with its weight of double superphosphate containing 33.7 per cent soluble phosphoric acid, of superphosphate containing 8.6 per cent soluble phosphoric acid, and of superphosphate gypsum, respectively,

and ground bone was mixed with nitrogen-free gypsum, with kainit, and with pure calcium carbonate. The materials in each trial were thoroughly ventilated. The separate trials lasted from 114 to 121 days. In each case the materials were inoculated with a drop of soil extract. The results of this series of experiments are summarized as follows: The two superphosphates allowed no ammonia to escape from the fermenting material; the superphosphate gypsum and pure gypsum sufficed to save considerable amounts of ammonia from loss, but far from the whole. Kainit retained the ammonia better than superphosphate gypsum or pure gypsum. The calcium carbonate was of no use in preventing the escape of ammonia, if it did not actually increase the amount generated. Another point of interest is that where the superphosphates of superphosphate gypsum were used no free nitrogen escaped, although this took place in the other cases, and especially with kainit.

The results of experiments by the author on peas, although numerous root tubercles were formed, gave no evidence of the fixation of atmospheric nitrogen by bacteria.

Another noticeable indication from the results of a series of experiments was that unsterilized soil possessed the ability to combine hydrogen and oxygen, a property which is believed to be in all probability due to the action of microörganisms, since the process was checked by chloroforming the cultures.

The principal points brought out in these investigations are summarized by the author as follows:

(1) In the decay of nitrogenous substances the loss of free nitrogen can occur independently of the formation of nitric acid; while in putrefaction under exclusion or partial access of air this does not take place.

(2) It remains to be decided whether or not a loss of free nitrogen occurs in the nitrification of ammonium salts under thorough ventilation.

(3) Enrichment of the soil with combined nitrogen by the fixation of this element from the air takes place not only in soils poor in nitrogen, as Berthelot states, but also in materials which are rich in nitrogen.

(4) Superphosphates are excellent materials for the conservation of barnyard manure. When these are used in sufficient amount and by free access of air there is no loss either from the volatilization of ammonia or escape of free nitrogen.

(5) Superphosphate gypsum is inferior to plain superphosphates for the conservation of manures. Its retentive power for ammonia is much less, but this material also prevented the escape of free nitrogen.

(6) Gypsum and kainit are inferior preservatives to the materials mentioned above. Although their ability to retain ammonia, especially in the moist fermenting substances, is not inconsiderable, an escape of nitrogen is to be feared by free access of air.

(7) Unsterilized soil after passing through the process of decay showed the ability to unite hydrogen and oxygen. This was probably due to bacteria.

TITLES OF ARTICLES IN RECENT FOREIGN PUBLICATIONS.

Progress in agricultural chemistry, a review (*Fortschritte auf dem Gebiete der Agriculturchemie*), J. König.—*Chem. Ztg., 1892, No. 34, pp. 568–573.*

Chinit, the simplest sugar of the inosite group (*Chinit, der einfachste Zucker aus der Inositgruppe*), A. Beyer.—*Ber. d. deut. chem. Ges., 25 (1892), p. 1037.*

Determination of starch (*Dosage de l'amidon*), Guichard.—*Jour. Pharm. Chim., tom. 25 (1892), ser. 5, p. 394.*

The separation of isomaltose from the products of the diastatic fermentation of starch (*Zur Gewinnung der Isomaltose aus den Producten der Stärkeumwandlung durch Diastase*), C. J. Lintner and G. Düll.—*Zeitsch. ges. Brauw., 15 (1892), p. 145.*

The production of dextrose from starch by means of fermentation (*Ueber die Entstehung von Dextrose aus der Stärke durch fermentative Processe*), C. J. Lintner.—*Zeitsch. ges. Brauw., 15 (1892), p. 123.*

Action of very dilute hydrochloric acid and of pepsin and hydrochloric acid on the digestible albuminoids of feeding stuffs (*Untersuchungen ü. die Einwirkung von starkverdünnter Salzsäure sowie von Pepsin und Salzsäure auf das verdauliche Eiweiss verschiedener Futterstoffe und Nahrungsmittel*), A. Stutzer.—*Landw. Vers. Stat., 40, Hefte 3 and 4, pp. 161–175.*

Innovations in the technology and the analysis of fats (*Neuerungen in der Technologie und Analyse der Fette*), R. Benedikt.—*Chem. Ztg., 1892, No. 38, pp. 650–653.*

Volumetric determination of phosphoric acid in fertilizers, M. Spica.—*Gazetta chimica italiana, 22 (1892), pp. 1 and 117.*

Determination of potash (*Dosage de la potasse*), F. Jean and Trillat.—*Bul. Soc. Chim., 7 (1892), ser. 3, pp. 228.*

Determination of kaolin in agricultural soils (*Die Kaolinbestimmung im Ackerboden*), R. Sachsse and A. Becker.—*Landw. Vers. Stat., 40, Hefte 3 and 4, pp. 245–255.*

Reports on water analysis, L. Taylor.—*Analyst, May, 1892, pp. 89–95.*

Some substances in the root tubers of Stachys tuberifera (*Ueber einige Bestandtheile der Wurzelknollen von Stachys tuberifera*), A. v. Planta and E. Schulze.—*Landw. Vers. Stat., 40, Hefte 3 and 4, pp. 277–298.*

The intensity of respiration in shade-loving plants (*Ueber die Athmungsintensität von Schattenpflanzen*), A. Mayer.—*Landw. Vers. Stat., 40, Hefte 3 and 4, pp. 203–216.*

Rain-making experiments (*Sur les moyens de provoquer artificiellement la formation des pluies*), Faye.—*Compt. rend., 114 (1892), pp. 962–967.*

The fuller's earth of Rosswein, Saxony (*Die Walkerde von Rosswein in Sachsen*), R. Sachsse and A. Becker.—*Landw. Vers. Stat., 40, Hefte 3 and 4, pp. 256–260.*

An improved sampling tube for taking samples of soils for investigation (*Der neue verbesserte Bohrstock zur Untersuchung des Bodens*), A. Nowacki and W. Borchardt.—*Deut. landw. Presse, 1892, No. 35, pp. 383, 384 (illustrated).*

The loss of fertilizing materials in drainage waters (*Das Drainagwasser und die durch dasselbe hervorgerufenen Verluste an Pflanzennährstoffen*), H. Scheffler.—*Berichte aus dem physiol. Lab. u. der Versuchsanstalt des landw. Instituts der Univ. Halle, 1891, Heft 8, pp. 69; abs. in Centralbl. f. agr. Chem., 21, Heft 3, pp. 145–148.*

Maercker's views on manuring with potash salts (*Maercker's Ansichten ü. die Düngung mit Kalisalzen*), M. Fleischer.—*Deut. landw. Presse, 1892, No. 41, pp. 445, 446.*

Report of comparative tests with different varieties of potatoes in 1891 (*Bericht ü. vergleichende Anbauversuche mit verschiedenen Kartoffelsorten im Jahre 1891*), F. Heine.—*Deut. landw. Presse, 1892, No. 29, p. 319; No. 30, pp. 331–333; No. 32, p. 353; No. 34, pp. 371–373; No. 37, pp. 402, 403; No. 40, p. 437; No. 41, p. 447.*

Composition of cooked vegetables, K. J. Williams.—*Jour. Chem. Soc., 61, pp. 226–241.*

Studies on dried brewers' grains (*Untersuchungen über getrocknete Biertreber*), A. STUTZER.—*Landw. Vers. Stat., 40, Hefte 3 and 4, pp. 311–316.*

Studies on tobacco smoke (*Beiträge zur Kenntniss des Tabakrauches*), M. ABELES and H. PASCHKIS.—*Arch. f. Hygiene, 14, Heft 2, pp. 209–215.*

The digestibility and the nutritive value of cellulose (*Ueber die Verdauung und den Nahrwert der Cellulose*), N. ZUNTZ.—*Pflüger's Arch., 49 (1891), pp. 477–484; abs. in Centralbl. f. agr. Chem., 21, Heft 2, pp. 88–90.*

Studies on the metabolism of swine fed on corn cockle (*Untersuchungen über den Stoffwechsel des Schweines bei Fütterung mit Kornrade*), C. KORNAUTH and A. ARCHE.—*Landw. Vers. Stat., 40, Heft, 3 and 4, pp. 177–202.*

Feeding for fat and for lean (*Fleisch und Fettmästung*), E. PFLÜGER.—*Pflüger's, Arch., 52, pp. 78.*

A practical case of successful diagnosis of tuberculosis by means of inoculation with tuberculin (*Ein praktischer Fall von Feststellung der Tuberkulose durch Impfung mit Tuberkulin*), DAMMANN.—*Sächs. landw. Zeitsch., 1892, No. 18, pp. 185–188.*

The average composition of milk, P. VIETH.—*Analyst, May, 1892, pp. 84–89.*

A rapid and accurate method of determining fat in milk, H. LEFFMANN and W. BEAM.—*Analyst, May, 1892, pp. 83, 84.*

On the inapplicability of the Werner-Schmid method to the anlaysis of condensed milk, B. DYER and E. S. ROBERTS.—*Analyst, May, 1892, pp. 81–83.*

The relations of the specific gravity of milk serum to the solids-not-fat (*Beziehungen des spezifischen Gewichtes der Molken zum fettfreien Trockenrückstand in der Milch*) E. REICH.—*Milch Ztg., 1892, No. 17, pp. 274–276; No. 18, pp. 289–291.*

Is sterilized milk more difficult of digestion than uncooked milk? (*Ist sterilisierte Milch schwerer verdaulich als rohe?*), A. STUTZER.—*Landw. Vers. Stat., 40, Hefte 3 and 4, pp. 317–319.*

Chemical and clinical studies on sterilized milk, A. R. LEEDS and E. P. DAVIS.—*Rev. falsific., 5, pp. 143, 144.*

Concerning the cause of stringy milk (*Beiträge zur Lehre von den Ursachen der fadenziehenden Milch*), A. GUILLEBEAU.—*Landw. Jahrbuch der Schweitz, 5, p. 91.*

The bacilli content and the rancidity of butter (*Ueber den Bazillengehalt und die Ranzigkeit der Butter*), NIEDERSTADT.—*Abs. in Milch Ztg., 1892, No. 20, p. 332.*

The acids of butter, E. KOEFOED.—*Bul. de l'académie royale danoise des sciences et des lettres pour l' anneé 1891, pp. 9; abs. in Centralbl. f. agr. Chem., 21, Heft 3, pp. 202–204.*

Analyses of butter and studies of butter fat (*Butter-Analysen und Butterfett-Untersuchungen*), P. VIETH.—*Milch Ztg., 1892, No. 20, pp. 330, 331.*

Studies on butter fat (*Untersuchungen von Butterfett*), M. SCHRODT and O. HENZOLD.—*Landw. Vers. Stat., 40, Hefte 3 and 4, pp. 299–309.*

The detection of margarines in butter (*Ueber den Nachweis der Margarine in der Butter*), H. RODEWALD.—*Landw. Vers. Stat., 40, Heft 3 and 4, pp. 265–275.*

On the composition of overripe cheese (*Ueber die Zusammensetzung des überreifen Käses*), A. MAGGIORA.—*Arch. f. Hygiene, 14, Heft 2, pp. 216–224.*

Manner of making and composition of the Bosnian Trappists' cheese (*Ueber die Herstellung und Zusammensetzung des bosnischen Trappistenkäses*), L. ADAMETZ.—*Milch Ztg., 1892, No. 19, pp. 310–313.*

On Fick's theory of the action of rennet and the clotting of blood (*Ueber Fick's Theorie der Labwirkung und Blutgerinnung*), P. WALTHER.—*Pflüger's Arch., 48 (1891), pp. 529–536; abs. in Centralbl. f. agr. Chem., 21, Heft 2, pp. 90–92.*

Spontaneous combustion of hay (*Die Selbstentzündung des Heues*), MADEM.—*Landw. Vereinssch. d. Baltischen Cent. Ver., 1892, No. 18, p. 71; No. 20, pp. 73, 74.*

Effect of dfferent wine yeasts on the character of wine (*Einfluss der verschiedenen Weinhefen auf den Charakter des Weines*), T. KOSUTANY.—*Landw. Vers. Stat., 40, Hefte 3 and 4, pp. 216–244.*

Prof. Gustav Kühn, Biographical sketches (*Fühling's Landw. Ztg., 1892, Heft 10, pp. 372–374; Deut. landw. Presse, 1892, No. 39, pp. 423, 424*).

EXPERIMENT STATION NOTES.

CALIFORNIA STATION.—Director Hilgard has recently issued a circular giving practical directions for the preparation of fruit specimens for the World's Columbian Exposition.

GEORGIA STATION.—Cheese making on a commercial scale has been begun under direction of the dairyman of the station, H. J. Wing, with a view to extending this industry in Georgia.

NEW JERSEY STATIONS.—It is proposed to add information regarding oyster culture to the crop reports of the New Jersey State weather service.

NEW YORK CORNELL STATION.—An agricultural conference will be held at the University June 10 and 11, 1892, on the invitation of the station. The program is as follows: How can the various societies by coördination do more and better work for agriculture? Hon. O. B. Potter and W. C. Gifford; University extension in the direction of agriculture, H. H. Wing and F. E. Smith; Legislation in regard to insects and plant diseases and recent attempts at nursery legislation, J. H. Comstock and W. C. Barry; How shall the farmers' institutes be made of most value to the State? G. T. Powell and J. Owen; What additional facilities should the university offer? (*a*) the special course, I. P. Roberts; (*b*) short winter course, J. S. Woodward; (*c*) short manual summer course, W. F. Rounds; (*d*) course in floriculture, H. A. Siebricht; Legislation and control of tuberculous cattle, J. Law and E. A. Powell; How may the experiment station extend its usefulness? N. W. Foster and L. H. Bailey.

SOUTH DAKOTA STATION.—The report of the Director for 1891, an abstract of which was published in Experiment Station Record, vol. III, p. 623, was prepared by L. Foster, instead of by his predecessor, as there stated.

A FOREIGN VIEW OF THE AMERICAN STATIONS.—An account of the agricultural experiment stations in the United States has been issued by Dr. F. Wohltmann of the University of Halle, in several recent numbers of the *Landwirtschaftliche Thierzucht.*

TOBACCO CULTURE IN ALABAMA.—With a view to encouraging the growing of tobacco, the State department of agriculture has distributed seed and issued a bulletin of information regarding the culture of this crop.

KANSAS STATION FOR EXPERIMENTS WITH CONTAGIOUS DISEASES OF THE CHINCH BUG.—The First Annual Report of the station for 1891 (pp. 230, plates 4), by its director, F. H. Snow, includes the text of the act of the State legislature, approved March 4, 1891, under which the station was established; résumés of the author's observations and experiments on the contagious diseases of the chinch bug in 1888, 1889, and 1890; detailed accounts of the laboratory and field experiments in 1891 under direction of the station; a discussion of the relation between meteorological conditions and the prevalence of the chinch bug and a history of mycrophytous diseases of the chinch bug in the United States. The station is connected with the State University, located at Lawrence. In 1891 the laboratory experiments were begun March 23 by introducing healthy chinch bugs from southern Kansas into jars infected chiefly with bacteria. In a few days most of the bugs in these jars were dead while others in check jars were still alive and healthy. Field experiments indicated that "the bacterial infection was not well adapted to the destruction of chinch bugs in the field in the months of April and May, when the nights were cool and sometimes frosty,

and the atmosphere was in general moist on account of abundant rainfall. It was found, however, that the comparatively few experiments in the field with the white fungus infection (*Sporotrichum globuliferum*) in April and May were almost without exception successful, resulting in the general destruction of the chinch bugs in the wheat fields."

Since the small size of the infection jars made it difficult to breed the infectious material in sufficient quantities for distribution, the author "provided two large cases with glass tops and sides, 6 feet in length by 3 feet in breadth, and 3 feet in height. Into each of these large cases were placed from 15,000 to 20,000 live, healthy bugs from the fields. These bugs were provided with fresh wheat plants every day for food, and among them were introduced a few of the white fungus bugs. In a short time the white fungus disease had become epidemic in these large cases, and in 10 or 12 days the bottoms of the cases were thickly sprinkled with the fungus-covered bodies of thousands of chinch bugs of all ages. From this time onward there was no difficulty in supplying the farmers with infection, although applications were received each day in numbers from 25 to 135.

"Later in the season it was found that common shallow dry-goods boxes or shoe boxes would fulfil the requirements of infection cages as successfully as the more expensive cases with glass sides and tops.

"The field experiments throughout the season were remarkably successful. Reports have been received from 1,399 of the more than 2,000 persons to whom infection was sent. Of these, 1,071 (or 76.55 per cent) indicate success, 181 (or 12.94 per cent) indicate failure, and 147 (or 10.51 per cent) are doubtful.

"The infectious diseases of the chinch bug have been introduced with destructive effect during all months of the year (from March to October) when chinch bugs have been active in the field. Crops of all kinds have been rescued from destruction—wheat, corn, oats, broom corn, barley, rye, sorghum, millo maize, Kaffir corn, timothy, and clover. * * *

"On June 28 *Empusa aphidis* was first noticed in the infecting case. Up to this date it had not made its appearance in our laboratory. From this time till the middle of August it multiplied its victims in the infecting cases. For a short time it became more conspicuous than *Sporotrichum*, and then subsided. * * *

"During July and August *Sporotrichum* continued to spread through successive lots of fresh bugs from the fields. *Empusa* was always present, but was not so conspicuous in its ravages as *Sporotrichum*. In the first weeks of September the diseases began to subside, and by the middle of October neither *Sporotrichum* nor *Empusa* appeared to be spreading further.

"[Young bugs as well as old ones were destroyed by the contagious diseases.] The evidence is abundant that as a rule only about 4 days elapse after the introduction of infection before the mass of the bugs in the vicinity of the spot where the infection is put entirely cease from their work of destruction. In cornfields where the stalks were black with bugs for a considerable distance above the ground at time of introducing the infection, the bugs in about 4 days became too sick to attempt the further feeding upon the crop. They then left the cornstalks, and although death did not ensue until from the eighth to the twelfth day, no damage was done to the crop after the fourth day. * * *

"It must be remembered that these contagious diseases of the chinch bug are naturally present in certain portions of the Mississippi basin during every year, and become epidemic over large portions of this area in occasional years. The object of my experiments has been to *artificially* introduce the diseases at times when they are not *naturally* raging in the fields. It was found in 1891 that there was no evidence of a natural existence of either of the three diseases in any part of the State of Kansas. This statement is abundantly substantiated by the detailed report of the field agent, Mr. Hickey, and by the reports of many farmers. * * * It was also established that in 1891 the disease did not spread to any great distance from one farm to another. Although in many counties farms immediately adjacent to a

successful experiment farm received the contagion from such farm, there was no evidence of a general epidemic resulting from the introduction of infection from my laboratory. * * *

"The experiments in the summer of 1890, which was a dry and hot season, showed that the bacterial disease was readily communicated and thoroughly effective under circumstances which are generally supposed to be highly unfavorable for the propagation of chinch bug disease. The experiments of the year 1891 were accompanied by similar results. * * *

"A remarkable peculiarity in the behavior of the sick bugs in many fields in midsummer demands especial attention. In many cornfields, the bugs, having abandoned their attack upon the corn at the end of about the fourth day, would wander about upon the surface of the ground for 2 or 3 days, and then would gather in bunches containing thousands of individuals. In 3 days more the majority would be dead. Examination of these clusters of bugs disclosed the fact that in many cases they were composed of the skins, together with the dead bodies of bugs. These skins have by some been considered as the natural results of the molting of the bugs. Examination during another season will probably reveal a more satisfactory explanation of this phenomenon than we are now able to give. Certainly healthy chinch bugs do not collect in such clusters upon the exposed surface of the ground for the purpose of molting. It is possible that the skins in these clusters are all that remain of bugs whose bodies have been distended by the multiplication of the *Micrococcus insectorum* and ruptured along the lines of least resistance.

"This peculiar bunching of the bugs the author considers to be the effect of bacterial disease. Similar bunching was continually observed in the large infection cases in the laboratory, and the bodies of the bugs in these bunches would be swarming with the fatal *Micrococcus*. It was observed, both in the laboratory and in the field, that the bodies of bugs sick with bacterial disease were unduly distended 2 or 3 days before death.

"It was observed by the field agent, and his observations are corroborated by the reports of farmers, that while the bugs were bunching in places where infection had been placed, they did not bunch in uninfected fields."

DAIRY SCHOOLS IN NEW YORK.—The Fifteenth Annual Report of the New York State Dairymen's Association for 1891 (pp. 233) contains accounts of the dairy schools and conferences held at the State Experiment Station and at six other places, together with the proceedings of the annual convention of the Association.

GREAT BRITAIN.—The yields of the principal crops in Great Britain in 1891, as estimated by the Board of Agriculture in its report of the statistics of agricultural produce, are summed up as follows:

Crops.	Estimated total produce.		Yield per acre.	
	1891.	1890.	1891.	1890.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*
Wheat	74, 742, 700	75, 993, 883	31. 30	30. 66
Barley	79, 555, 089	80, 793, 525	34. 72	35. 23
Oats	166, 472, 428	171, 295, 404	40. 46	41. 54
Beans	10, 694, 376	11, 859, 633	29. 83	32. 77
Peas	5, 777, 445	6, 312, 910	28. 23	28. 71
	Tons.	*Tons.*	*Tons.*	*Tons.*
Potatoes	6, 090, 047	4, 622, 214	4. 74	3. 53
Turnips	29, 741, 587	32, 002, 201	13. 40	14. 27
Mangle-wurzels	7, 558, 216	6, 708, 886	18. 60	17. 76
	Cwt.	*Cwt.*	*Cwt.*	*Cwt.*
Hay from clover, sainfoin, etc	25, 566, 162	97, 045, 740	31. 39	33. 19
Hay from permanent pasture	167, 862, 776	192, 275, 600	28. 13	30. 81
Hops	436, 716	283, 629	7. 78	5. 26

SCOTLAND.—The Annual Report of the Agricultural Research Association for 1891 (pp. 38, plates 4), by T. Jamieson, contains accounts of experiments with grass mixtures, clover, superphosphates on clover, alfalfa, serradella, flax, fertilizers for turnips,

and time of harvesting grain. The results of an extended investigation of the structure of root hairs are also reported.

Grass mixtures.—The following mixtures of seed are recommended: For hay, perennial rye grass 10 pounds, Italian rye grass 5, meadow fescue 3, tall fescue 3, *Poa trivialis* 2, dog's-tail 1, and clovers (red, cow grass, white, Dutch, and yellow) 8; total 32. For grazing, the same mixture, except that 1.5 pounds of each of the fescues and 3 pounds of cocksfoot (orchard grass) are to be substituted for the amounts of the fescues stated above.

Clover tubercles.—Experiments with different fertilizers indicated that superphosphate increased the number of tubercles on the roots of clover plants. When clover plants were grown in glass vessels containing soil to which different amounts of superphosphate had been added the number of tubercles increased with the amount of superphosphate applied. Thus in one case the numbers of tubercles were as follows: With no superphosphate 40, with 0.5 gram 61, with 1 gram 76, with 1.5 gram 120. "It was found that the tubercles were aggregated more or less clearly (though this was not always adhered to) just where the superphosphates lay, and the size of the tubercles also seemed to increase with the increase of the sulphuric manure." The author believes that the sulphuric acid with which the superphosphate is treated contributes to the growth of tubercles on the roots of plants.

Root hairs.—The structure and function of root hairs are discussed, and observations by the author are described and illustrated. It is claimed that an aperture has been observed at or near the tip of the root hairs of different kinds of plants and that minute particles of solid substances have been seen within the tube communicating with this aperture. The inference is drawn that plants "take up their solid food in the solid form through root-hair apertures." The differing effects of fertilizers are therefore to be explained with reference to this theory.

NEW SOUTH WALES.—The report of the administration of the "dairies supervision act" for 1891 shows that the area of dairy inspection has been increased, and that the law is doing much to secure a pure milk supply. Special attention has been given to an examination of the water used at the dairies, which in many cases has been found to be polluted. In a number of instances persons affected with infectious diseases were found on dairy premises and were removed to hospitals.

Detailed information regarding courses of instruction in agriculture, horticulture, and apiculture may be found in the Calendar of Technical Education for 1892 issued by the Department of Public Instruction.

ONTARIO.—The following bulletins issued by the Bureau of Industries have recently been received: No. 38, November, 1891, Crops and Live Stock in Ontario (pp. 14); No. 39, April 22, 1892, The Silo and Corn Ensilage (pp. 8); No. 40, April 22, 1892, Crops and Live Stock in Ontario (pp. 4). The first and third of these publications contain general statistics of the staple crops, dairying, and farm animals in Ontario; the second gives information regarding the culture and storage of silage corn, the construction of silos, and the cost and value of silage, based on the experience of farmers in Ontario.

PROTECTION OF BEES.—The following act was passed by the legislative assembly of Ontario, April 8, 1892:

"(1) No person in spraying or sprinkling fruit trees during the period within which such trees are in full bloom shall use or cause to be used any mixture containing Paris green or any other poisonous substance injurious to bees.

"(2) Any person contravening the provisions of this act, shall on summary conviction thereof before a justice of the peace, be subject to a penalty of not less than $1.00 or more than $5.00 with or without costs of prosecution, and in case of a fine or a fine and costs being awarded, and of the same not being upon conviction forthwith paid, the justice may commit the offender to the common gaol, there to be imprisoned for any term not exceeding 30 days unless the fine and costs are sooner paid.

(3) This act shall not come into force until the first day of January, 1893."

PROF. GUSTAV KÜHN.—Brief mention was made in the last number of the Record of the death of Professor Kühn, the director of the oldest German experiment station.

Gustav Kühn was born in Paris, January 20, 1840, where his parents were then sojourning. He went to Germany with his parents at an early age, attended the public schools in Leipsic and the universities at Liepsic, Göttingen, and Greifswald, receiving the degree of Doctor of Philosophy at the last-named place in 1861. From 1861 to 1862 he was assistant in chemistry in that institution, and from 1862 to 1865, assistant in the experiment station at Weende, near Göttingen, where he studied under Professor Henneberg the methods of investigation in animal physiology then being worked out. In 1866 he became director of the station at Brunswick, and in 1867 he succeeded Knopf as director of the station at Möckern, which position he occupied at the time of his death. A list of the principal investigations published by Kühn is as follows: Experiments in feeding milch cows with clover forage; Experiments on the digestibility of red clover at different stages of growth; Experiments on the digestibility of red clover in bloom when fed green and when made into hay; Experiments on the digestibility of green lucern and of hay from the same; Experiments on the changes in digestibility of coarse fodders by feeding them in connection with easily digestible materials, and on the digestibility of rape cake, linseed cake, and extracted palm nut meal; On the formation of fat in the animal body; Experiments on the effect of changes of food on the milk production of cows, as well as on the digestibility of meadow hay and the changes occurring in the same when small amounts of easily digestible foods were added; Experiments on the effect of food on the milk production of cows; Experiments on the digestibility of wheat bran and its changes with different methods of preparation and feeding, as well as on the digestibility of meadow hay when fed dry and when moistened; and Whole milk and skim milk as human food. In addition to these he left a large amount of unpublished work. This consists principally of experiments with the Pettenkofer respiration apparatus on the formation of fat from carbohydrates in full-grown oxen; investigations on the agreement between the artificial digestion of nitrogen-free food constituents and their natural digestion by oxen; on the determination of the nitrogen excreted in the form of metabolic products with the dung; report on the digestibility of rye bran, dried brewers' grains, rice meal, cotton-seed meal, peanut cake, extracted anise seed, ground beet residue, cocoa meal, and poppy-seed cake. These, it is reported, will be prepared for publication.

Dr. Oscar Böttcher, formerly first assistant, has been appointed acting director of the Möckern station.

DR. MAX SCHRODT.—The death is reported of Dr. Max Schrodt, since 1879 director of the dairy division of the experiment station at Kiel, Germany. He was closely allied with the development of that institution, which occupies a prominent position among the institutions for dairy research. With Professor Emmerling he issued the Communications from the Agricultural and Dairy Experiment Station at Kiel in 1879, and was a frequent contributor to agricultural journals. Of especial interest were his annual reports of the dairy experiment station and school at Kiel. Dr. Schrodt was 44 years old.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING MAY, 1892.

Report of the Secretary of Agriculture, 1891.

DIVISION OF STATISTICS:

Report No. 95 (new series), May, 1892.—Condition of Winter Grain; Progress of Cotton Planting; Freight Rates of Transportation Companies.

Report No. 2 (miscellaneous series).—Agriculture of South America; Maps and Latest Statistics of Trade.

Report No. 3 (miscellaneous series).—Coöperative Credit Associations in Certain European Countries and their Relation to Agricultural Interests.

Report No. 4 (miscellaneous series).—Wages of Farm Labor in the United States.

WEATHER BUREAU:

Monthly Weather Review, February, 1892.

Circular B.—Directions for Use of Maximum and Minimum Thermometers.

Circular C.—Instructions for Use of the Rain Gauge.

BUREAU OF ANIMAL INDUSTRY:

Farmers' Bulletin No. 8.—Results of Experiments with Inoculation for the Prevention of Hog Cholera.

DIVISION OF ENTOMOLOGY:

Bulletin No. 27.—Reports on Damage by Destructive Locusts during the Season of 1891.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Record, vol. III, No. 10, May, 1892.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING MAY, 1892.

AGRICULTURAL EXPERIMENT STATION OF THE AGRICULTURAL AND MECHANICAL COLLEGE OF ALABAMA:

Bulletin No. 37, March, 1892.—Tobacco.

STORRS' SCHOOL AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 8, April, 1892.—Summary of the Annual Report for 1891.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF ILLINOIS:

Bulletin No. 20, April, 1892.—Field Experiments with Corn.

KANSAS AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 30, December, 1891.—Experiments with Corn.

Bulletin No. 31, December, 1891.—Sugar Beets.

MARYLAND AGRICULTURAL EXPERIMENT STATION:

Fourth Annual Report, 1891.

Bulletin No. 14, September, 1891.—Wheat.

Bulletin No. 15, December, 1891.—Experiment Vineyard.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:

Bulletin No. 18, April, 1892.—Soil Tests with Fertilizers; Experiments with Different Crops.

Bulletin No. 19, May, 1892.—Report on Insects.

Meteorological Bulletin No. 40, April, 1892.

MISSOURI AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 17, January, 1892.—Sugar Beets.

NEVADA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 14, December, 1891.—Potato Experiments.

NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS:

Annual Reports, 1891.

Bulletin No. 87, April 13, 1892.—Analyses of Commercial Feeds.

Special Bulletin Q, April 21, 1892.—Some Fungous Diseases of Celery.

NEW YORK AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 40 (new series), March, 1892.—Black Knot of Plum and Cherry.

Bulletin No. 41 (new series), April, 1892.—Experiments with Fungicides.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION:

Bulletin No. 83*d*, March 29, 1892.—Meteorological Summary for North Carolina, February, 1892.

Bulletin No, 85*a*, April 27, 1892.—Meteorological Summary for North Carolina, March, 1892.

OHIO AGRICULTURAL EXPERIMENT STATION:

Bulletin vol. v, No. 2 (second series), February, 1892.—Mangel-Wurzels and Sugar Beets.

Bulletin vol. v, No. 3 (second series), March, 1892.—Field Experiments with Commercial Fertilizers.

Bulletin vol. v, No. 4 (second series), April, 1892.—Insects which Burrow in the Stem of Wheat.

Rhode Island State Agricultural Experiment Station:

Bulletin No. 15, April, 1892.—Treatment of Loose Smut of Oats; Fungicides and Insecticides and their Use.

South Dakota Agricultural Experiment Station:

Bulletin No. 27, November, 1891.—The Sugar Beet in South Dakota.

Texas Agricultural Experiment Station:

Bulletin No. 20, March, 1892.—Grasses and Grains.

Vermont State Agricultural Station:

Bulletin No. 27, January, 1892.—Tests of Dairy Apparatus.

Bulletin No. 28, April, 1892.—Plant diseases.

Virginia Agricultural and Mechanical College Experiment Station:

Bulletin No. 12, January, 1892.—Tests of Fertilizers on Tobacco.

Bulletin No. 13, February, 1892.—Antiseptic Treatment of Wounds; Infectious Abortion in Cows.

Agricultural Experiment Station of the University of Wisconsin:

Eighth Annual Report, 1891.

Bulletin, No. 31, April, 1892.—Notes on the Use of the Babcock Test and the Lactometer.

Wyoming Agricultural Experiment Station:

Bulletin No. 6, May, 1892.—Soils of the Agricultural Experiment Farms.

DOMINION OF CANADA.

Bureau of Industries, Toronto, Ontario:

Bulletin No. 38, November 9, 1891.—Crops and Live Stock in Ontario.

Bulletin No. 39, April 22, 1892.—The Silo and Corn Silage.

Bullitin No. 40, April 22, 1892.—Crops and Live Stock in Ontario.

U. S. DEPARTMENT OF AGRICULTURE

OFFICE OF EXPERIMENT STATIONS

A. W. HARRIS, DIRECTOR

EXPERIMENT STATION RECORD

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EXPERIMENT STATION RECORD.

Vol. III. ISSUED JULY, 1892. No. 12.

EDITORIAL NOTES.

The diminishing profitableness of cotton culture has drawn public attention to the necessity for the diversification of agriculture in the South. Social and economic conditions have thus far powerfully retarded the change which is inevitable. Cotton is the money crop. The land is largely worked by tenants. The merchants make their advances of money and goods on cotton. The landlords insist that cotton is the only crop furnishing a sufficient security for the payment of rent. Add to this the fact that the agricultural information of the tenants is almost entirely confined to their knowledge of cotton culture, and it at once appears that it will require influences strong as necessity to bring about the substitution of other crops for King Cotton. In considering the work of the experiment stations in the States where cotton is the chief crop, it is well to remember that it will not be sufficient for them to demonstrate that this or that crop can be profitably grown. Labor must be educated. The landholding and the trading classes must be convinced that new crops will furnish a stable basis for commercial paper and rentals.

Among the agricultural problems of the greatest importance to the future success of the Southern farmer are those connected with the growth of grasses and forage plants. This Department and the stations, working in many instances in coöperation, are making numerous tests of old and new species and varieties. Sufficient progress has already been made to show that while different species are required to meet the varying conditions of soil and climate, an abundance of pasturage and of green fodder can be produced in all parts of the South when an intelligent effort is made to do so. That there are still large regions where the feeding stuffs required by the farm animals used in raising cotton are imported from the West and North, only emphasizes the extreme folly which characterizes the present system of agriculture.

Under such conditions the educative function of the stations comes into peculiar prominence. The ordinary methods of distributing information through bulletins and the press will not suffice. Personal

appeals must be made to the farmers through lectures and farmers institutes. Intelligent men in many localities must be persuaded to give object lessons to their neighbors by following on their own farms the course recommended by the stations. Study must be devoted to adapting the means of persuasion to the peculiar conditions of different communities. While scientific researches on special problems of general interest should not and need not be neglected, what is especially needed at the present crisis is to hold public attention to the facts already ascertained. No opportunity should be lost to urge that the agriculture of the South must and can be diversified, to point out what crops can be profitably added to those now grown, and to teach the best methods for their culture. The Southern stations are already doing much to mold public opinion on this great problem. It is chiefly for their encouragement that we call the attention of our readers to this subject. In judging of the work of these stations it is important to keep in mind that their task is not simply to amend agricultural practice in particular points but to promote a general change in the system of farming. Whatever work they may do in the laboratory and the field must be supplemented by vigorous campaigning among the people. Wise planning and skillful generalship, combined with the missionary spirit, are required to make their efforts successful in rescuing the farmers of their section from the poverty into which blind adherence to the traditions of the past will be sure to drag them. A grave responsibility rests upon leaders in agricultural science and education under such circumstances. If, however, they succeed they will establish the cause of agricultural research on an enduring foundation.

The present number completes the third volume of the Experiment Station Record. A classified table of contents and a full index will be issued for this, as for the second volume. The list of abstracts includes 302 bulletins and 46 annual reports of the stations, 62 publications of this Depatmrent, and 159 foreign articles. It will be observed that while the number of station and Department publications has not increased, the space devoted to accounts of foreign work has been greatly enlarged. A new feature introduced in the later numbers of the volume is the list of titles of articles in foreign publications. Considerable progress has been made in extending the number of foreign journals regularly received and examined by this Office and it is hoped hereafter to still further widen our outlook in this direction. A list of the publications issued by the American agricultural colleges and experiment stations from the time of their establishment down to January 1, 1892, has been included in the present number. The Office has thus far been unable to obtain the titles of a few of these publications, but it is hoped that the publication of the list will bring out the desired information regarding them.

Attention is once more called to the fact that the index to the Record is a guide to the contents of all the publications abstracted. The three volumes of the Record, together with Experiment Station Bulletin No. 2, make it possible to obtain ready access to very nearly all the information which the American stations have published since their organization under the act of Congress of March 2, 1887. Binding the volumes as they are completed greatly decreases the task of consulting them.

ABSTRACTS OF PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

Alabama College Station, Bulletin No. 36, March, 1892 (pp. 32).

SOME LEAF BLIGHTS OF COTTON, G. F. ATKINSON, PH. B. (plates 2).—This includes articles on the yellow and red leaf blights of cotton.

Yellow leaf blight (pp. 2–31).—Under this name investigations on the disease commonly known as black rust are reported. In view of the confusion existing in regard to the application of the term "rust" to diseases of cotton, the author urges the adoption of the name yellow leaf blight for the particular disease described in this bulletin. In a preliminary report on investigations of this disease in Bulletin No. 27 of the station (see Experiment Station Record, vol. III, p. 7) it was stated that several species of fungi "play an important part in the disease." Later investigations have shown that while these organisms aggravate the disease they do not cause it. Yellow leaf blight is found to be a physiological disease due to imperfect nutrition or assimilation.

The effect of this deficiency, either in nutrition or assimilation, is shown in a partial disorganization of the chlorophyll or green substance which causes it to become yellow in color. At first this change in color is quite indistinct, but gradually becomes more marked, until it is plainly seen. Where this takes place it gives to the leaf a checkered appearance, the cells along the channels in the veinlets which bound the yellowish areas remaining quite green for some time. Sometimes the disease progresses more rapidly so that the smaller veins are also yellow and it is only along quite close to the larger veins and their branches that the green color is present. In the further progress of the disease, if the weather continues quite dry, the leaf after a while will gradually dry, become shriveled, and fall off. If rain and hot weather succeed each other, semiparasitic fungi grow in the leaf, absorbing the living substance for their own growth. * * *

We are not at present in a position to say with certainty whether it is induced by the lack of some nutritive element in the soil or whether the physical condition of the soil has become deranged either by long cultivation, by washing away of the surface soil, or in some cases by an original detrimental physical condition of the soil, when the disease is said to appear any year under all conditions. It is certainly not exclusively due to an impoverished condition of the soil, for it appears in some of the richest lands of the State. It may be that both of these conditions are more or less responsible for the trouble.

Experiments to test the effects of fungicides and of fertilizers were made at Auburn, Matthews Station, and Hope Hull, Alabama, in 1891. The fungicides used (Bordeaux mixture, eau celeste, and copper sulphate) were without effect. Kainit, nitrate of soda, salt, cotton-seed meal and phosphate, blood and bone meal, bone meal, and compost were used as fertilizers in various amounts and combinations. The beneficial effects of kainit, alone and in combination with other fertilizers, were clearly apparent. The favorable experience of other experimenters in the use of kainit as a preventive for this disease is also cited. The influence of kainit on the yield of cotton on different soils is indicated by reference to experiments in Alabama, North Carolina, South Carolina, and Mississippi. The physical conditions of the soil, which prevent a proper circulation of soil water and thus probably cause the disease under consideration, are discussed.

The disease is liable to occur on many soils where the surface soil has largely been washed away by rains; on very porous soils, whether sandy or lime lands; and on poorly drained low ground. It is of more frequent occurrence in what is known as the prairie section, but in years like the past one it occurs in the sandy uplands as well.

At my request Mr. Clark has prepared the following statement of lands in the prairie section which, according to his observations, are subject to the disease.

As regards the liability of different soils in my section to produce the disease called yellow leaf blight in cotton: (1) If the surface soil is washed away, and the subsoil of whitish color filled with particles of lime is exposed, the cotton will always blight. (2) If the soil is black gunpowder or loose gray, cotton will blight more or less every year. (3) Good, heavy, well-drained clays seldom blight; in fact, last year was the only time in 11 years that clay lands blighted with me, and it was not developed even then as much as on other soils.

Statements from various sources are cited to show how physical conditions of the soil may be changed by the use of alkaline lyes, wood ashes, muriate of potash, salt, humus, or kainit, or by cultivating or rolling the ground.

Red leaf blight (pp. 31, 32).—"Red rust" is a term frequently applied to a reddened condition of the plant often seen on worn-out sandy land, or uplands. It is a hastened maturity of the plant, induced by an impoverished condition of the soil, showing a lack of nitrogen and potash, and probably also phosphoric acid. A red coloring substance, known as erythrophyll, is developed in the cell sap of the leaves. This can be remedied by proper fertilizing.

A brief account is given of experiments to test the efficiency of a preparation known as "Cerealite" in preventing this disease. The results varied on different soils.

Alabama College Station, Bulletin No. 37, March, 1892 (pp. 20).

Tobacco, A. J. Bondurant (plate 1).—Practical directions for the culture, curing, and marketing of tobacco, published with a view to encouraging the growing of this crop more generally in the State. The station intends to make experiments on tobacco.

Arizona Station, First and Second Annual Reports, 1890 and 1891 (pp. 3 and 7).

Brief statements regarding the organization and work of the station, and financial reports for the fiscal years ending June 30, 1890 and 1891.

Arizona Station, Bulletin No. 5, April, 1892 (pp. 6).

CAÑAIGRE, F. A. GULLEY, M. S.—A preliminary statement regarding investigations in progress at the station with a view to determine whether cañaigre (*Rumex hymenosepalus*) can be profitably cultivated for the tannin which its roots contain.

Arizona Station, Bulletin No. 6, April, 1892 (pp. 8).

MESA SOIL AND COLORADO RIVER WATER, C. B. COLLINGWOOD, M. S.—Mechanical and chemical analyses of a mesa soil near Yuma, Arizona, are tabulated. "The soil is warm, easily drained, free from alkali, and deficient in humus, but not deficient in plant food. If supplied with active fertilizing material and organic matter it is especially adapted to early fruits and vegetables."

Chemical analyses of the sediment from samples of Colorado River water taken daily for 7 months (August to February) are tabulated, together with calculations of the amount and value of the fertilizing materials deposited by the river. The average number of pounds of material deposited by 1 acre inch (27,152 gallons) of water during each of the 7 months, was as follows: Total residue 818, clay 204, lime 58, phosphoric acid 1.32, available potash 1.20, and nitrogen 0.71. A comparison of the amounts of sediment deposited by different rivers, expressed in terms of the ratio of solids to weight of water, is stated as follows: Colorado (average of 7 months) 1 : 277; Mississippi, 1 : 1500; Nile, 1 : 1900; Danube, 1 : 3060. The clay and silt deposited improve the texture of the soil, the plant food is largely available, and alfalfa can be grown to supply organic matter. In this way, with the aid of irrigation, the mesa soils can be made productive. The station will continue its examination of the irrigation waters of the State.

Connecticut State Station, Bulletin No. 111, March, 1892 (pp. 20).

COMMON FUNGOUS DISEASES AND THEIR TREATMENT, W. C. STURGIS, PH. D. (plates 4, fig. 1).—Popular accounts of the following diseases, with suggestions for treatment: Apple scab (*Fusicladium dendriticum*), ripe or bitter rot of apples (*Glœosporium fructigenum*), leaf blight or spot of pears and quinces (*Entomosporium maculatum*), peach yellows, black knot of the plum and cherry (*Plowrightia morbosa*), brown rot of stone fruits (*Monilia fructigena*), black rot, brown rot or

downy mildew, and anthracnose of grapes (*Physalospora bidwellii, Plasmopara viticola*, and *Sphaceloma ampelinum*), anthracnose of raspberries and blackberries (*Glœosporium venetum*), leaf blight of strawberries (*Sphærella fragariæ*), onion smut (*Urocystis cepulæ*), potato rot (*Phytophthora infestans*), and leaf blight of tomatoes (*Cladosporium fulvum*). Formulas are given for Bordeaux mixture, ammoniacal carbonate of copper, and ammonia-copper solution. Spraying apparatus is described and illustrated.

Illinois Station, Bulletin No. 20, April, 1892 (pp. 24).

FIELD EXPERIMENTS WITH CORN, G. E. MORROW, M. A., AND F. D. GARDNER, B. S. (pp. 49–71).—This article gives an account of experiments with corn in 1891, together with a summary of similar experiments in 1888, 1889, and 1890, which were recorded in Bulletins Nos. 4, 8, and 13 of the station (see Experiment Station Record, vol. I, p. 28; vol. II, pp. 14 and 556). The following subjects were treated: Test of varieties, time of planting, thickness of planting, planting in hills or drills, depth of plowing, depth of cultivation, effect of root pruning and of fertilizers, increase of dry matter with the growth of the corn plant, and effect of removing tassels. There are also practical suggestions for corn culture in Illinois.

"The season was one of severe drouth. The rainfall had been deficient in 1890 and in the early months of 1891. For the 5 months from May to September it was 7.65 inches, the average for this portion of the year being from 18 to 20 inches. The average mean temperature for these 5 months was 68° F., which was not far from the average during a series of years."

Experiment No 1.—Corn, test of varieties (pp. 51–60).—The varieties tested in 1891 included 22 yellow dent, 12 white dent, and 2 mixed dent. The results, as in the case of the similar experiments previously reported, are given in detail in tables, summaries, and general notes.

Experiment No. 3.—Corn, time of planting (pp. 60–62).—In 1891 Burr White, a medium-maturing variety, was planted at eight different dates at intervals of a week, from April 25 to June 13. The average height of the tallest stalks on each plat, measured each week from June 8 to September 21, is tabulated, together with the yield of corn and per cent of water in the corn.

Experiment No. 5.—Corn, thickness of planting (pp. 62–65).—Tabulated details are given for two experiments described as follows:

On a tract of fall-plowed land 27 rows of corn 3 feet 8 inches apart, were planted, 3 rows with single kernels 3 inches apart, 3 with single kernels 6 inches apart, and 3 with single kernels 9 inches apart; also 3 rows with 3 kernels every 9 inches, 3 with 3 kernels every 18 inches, and 3 with 3 kernels every 27 inches. This was at the rate of 47,520, 23,760, and 15,840 kernels per acre.

The weight of 100 ears, and of 100 stalks, the number of ears, and the bushels of corn per acre were greatest from the thinnest plantings and least from the thickest

plantings. The total yield and the yield of stalks was greatest from the thickest planting. Corresponding results have been secured in each of the three preceding years. * * *

A second experiment was made to compare the effect of planting in hills at different distances and with different numbers of kernels in the hills.

The tract used for this experiment had been in corn in 1890 and was fall-plowed. There were 36 plats, each 9 hills square, so planted that corn grew on every side of each plat. May 14 the corn, which was Leaming and Burr White, medium-maturing varieties, and Early Butler, an early-maturing variety, was dropped by hand and covered with a hoe. June 1 to 27 the corn was cultivated three times with a shallow-going cultivator and the remaining weeds removed with a hoe.

October 26 to 29 the corn was husked and the number of barren stalks, the total number of stalks, the number of ears, and the weight of ears were ascertained for each plat. The distance between hills, the number of kernels per hill, the ratio of stalks grown to kernels planted, the per cent of barren stalks, the number per acre of kernels planted, stalks grown, and ears harvested, the weight of 100 ears, and the yield per acre in bushels (70 pounds per bushel) for each plat of each variety are given in the table.

In general as the rate of thickness in planting increases the ratio of stalks grown to kernels planted and weight of 100 ears decrease, while the per cent of barren stalks increases. The same is more noticeable in the table giving the average of 4 plats for each of the six rates of planting. In this table also it will be seen that, excepting the thickest planting, the yield per acre increases with the increase in rate of planting.

Experiment No. 6.—Corn, planting in hills or drills (p. 65).—On one plat Burr White corn was planted in drills and on another in hills under the same conditions. The land was cultivated one way. The yields were exactly the same on the 2 plats. In 1890 there was a considerably larger yield from planting in hills.

Experiment No. 7.—Corn, depth of plowing (p. 65).

May 16, 1891, 3 equal and adjacent plats were plowed as nearly as possible at depths of 2, 5, and 10 inches, and planted to corn. October 23, when harvested, they yielded respectively 51, 57.5, and 56 bushels per acre. The difference in yield was so slight that it can not be said with confidence that the difference in the depth of plowing caused it.

In 1890 the yields from 5 adjacent plats, with seed bed stirred to different depths, were as follows: Not plowed (disked shallow) 56.4, plowed 2 inches 59.9, plowed 4 inches 69.4, plowed 6 inches 69.3, plowed 8 inches 71.7 bushels per acre. None of these plats had any cultivation after planting, except removing the weeds by scraping the surface with a sharp hoe.

Experiment No. 9.—Corn, depth of cultivation (p. 66).—Deep and shallow cultivation were compared with each other and with no cultivation. The results are stated in a table. The following is a summary of experiments in this line at the station during 4 years.

Yields of corn on plats differently cultivated, 1888–91.

Kind of cultivation.	Bushels per acre.				
	1888.	1889.	1890.	1891.	Average.
Shallow, ordinary	93.8	84.6	66.8	58.4	75.9
Deep, ordinary	84.9	74.2	60.8	63.4	70.8
None, weeds scraped from surface	90.0	77.1	69.1	55.3	72.9

Experiment No. 10.—Root pruning (pp. 66–68).—" Every alternate row of 18 rows 2 rods long, of each of the 4 plats used in experiment number 9, was root pruned three times from June 19 to July 10, to a depth of 4 inches. The pruning was done by placing around each hill a frame 12 inches square on the outside and passing around its outer edge a gauged knife."

The results are stated in detail in a table. The following is a summary of experiments in this line during 4 years:

Yields of corn with and without root pruning, 1888–91.

Kind of cultivation.	Bushels per acre.											
	1888.			1889.			1890.			1891.		
	Unpruned.	Pruned.	Differences.	Unpruned.	Pruned.	Differences.	Unpruned.	Pruned.	Differences.	Unpruned.	Pruned.	Differences.
Shallow, ordinary	97.0	91.0	6.0	90.9	78.3	12.6	78.7	55.0	23.7	70.0	48.7	21.3
Deep, ordinary	87.0	83.2	3.8	80.9	67.6	13.3	70.8	50.7	20.1	79.4	56.0	23.4
None, weeds scraped off	94.0	85.5	8.5	85.8	68.4	17.4	76.7	61.5	15.2	66.3	39.7	26.6
Averages	92.7	86.6	6.1	85.9	71.4	14.4	75.5	55.7	19.7	71.9	48.1	23.8

Experiment No 11.—Corn, effect of fertilizers (p. 68).

As stated in former bulletins, no important effect on yield of corn has been produced by the application of any of the more common forms of artificial manures to the fertile prairie lands on the university farms. The application of stable manure has, almost without exception, increased the yield, but not in all cases enough to repay directly the outlay. * * *

For 3 years experiments have been tried at different points in this State, about in the latitude of St. Louis, in the light-colored soil of that region. Owing to unfavorable conditions—drouth and storms—or to injuries by insects the results have been very unsatisfactory. The effect of applying stable manure has been uniformly good.

Experiment No 90.—Corn, increase of dry matter with the growth of the plant (pp. 68, 69).

For 3 years observations have been made on the rate of growth and on the rate of increase of dry matter in the corn plant. The results each year have shown that there is relatively very little dry matter in the corn plant in the early stages of its growth. * * * For 3 years plats of corn have been cut for fodder at three different periods—as nearly as might be when the ears were in the milk stage, when they were nearly mature, and when the plant was fully ripened. In each year there was a noticeably smaller yield, both of the whole crop and of the grain, from the early-harvested plats than from either of the others. The yield of corn has been largest from the fully ripened plats. These experiments, and the feeding tests which have accompanied them, will be repeated and fully reported.

Experiment No. 134.—Corn, effect of removing tassels (p. 69).

The tassels on alternate rows of four tenths of an acre of Burr White corn were removed as soon as they appeared. Each of the 30 rows was husked and weighed separately. The total difference between those having the tassels removed and those not removed was but 1 pound, thus showing no effect from removing tassels. In similar

trials with sweet corn the yield was somewhat reduced when the tassels were removed.

Removing the tops by cutting them off above the ears just before the leaves began to turn brown had no appreciable effect upon the yield of grain.

Summary of experiments with corn (pp. 50, 51).

In 1891, 36 varieties were tested on 52 plats. About 86 per cent of a full stand of stalks was secured. About 12 per cent of the stalks produced no ears. This is nearly the same result as found in 1888 and 1890. In 1889 there was less than 2 per cent of barren stalks. While the percentage of stalks does not seem to depend on variety, there were great differences in different plats—from 3 to 29 per cent.

As had been the case in each of the 3 preceding years, the varieties maturing about September 20 gave a larger average yield than those maturing either earlier or later. In 1891, 13 early varieties averaged 56, 19 medium averaged 66, and 6 late-maturing varieties averaged 57 bushels of air-dry corn per acre. For the 4 years the early varieties gave an average yield of 61, the medium 73, and the late 68 bushels of air-dry corn.

For 4 successive years 11 varieties have been tested. The average yield has been at the rate of 70 bushels per acre. Of these varieties Champion White Pearl has had the highest average, 79 bushels; Leaming (yellow) the next, 76 bushels; Burr White, which resembles Champion White Pearl, next, 74 bushels. Boone County White gave much the largest yield, 89 bushels, in 1891, and as large as any other in 1890. Leaming gave the largest yield of any yellow variety in 1891. Murdock and Edmonds stood highest in yield of the early-maturing varieties tested for 4 years. A plat of Murdock did not ripen until September 20, while 1 plat of Leaming matured so as to be classed with the early varieties; but these were exceptional cases.

In some cases marked differences were found in the yield of adjacent plats of the same variety. In the case of 1 variety there have been extraordinary variations in yeld in different years. In each of the 4 years varieties little known and without more than a neighborhood reputation have given large yields of good corn. The yield does not seem to depend on the color or the smoothness or roughness of the kernels, although in 1891, the white varieties gave an average of 4 bushels larger yield than the greater number of yellow varieties.

A medium-sized variety of corn, planted at the rate of one kernel each 9 to 12 inches in rows 3 feet 8 inches apart, gave larger yields of good corn than thicker planting; but the yield of corn and stalks together increases with thickness of planting, at least up to the rate of one kernel each 3 inches. As the result of 4 years' trials it is believed the larger yield of grain makes the food value of the total crop greater when it is planted at the rate of one kernel to about each 6 inches in the row.

In 1891, little difference was found in yield from plats planted with a medium-maturing variety at weekly intervals from April 25 to May 23. Later plantings gave much smaller yields; the ears were not well filled, and the corn did not mature thoroughly. For 3 years previous good crops were had from plantings any time in May. For the 4 years the best results have come from planting from May 11 to 16.

In 2 out of 3 years no material difference in yield has been found, whether the corn has been planted in hills or drills, if the land was kept equally free from weeds.

The yields were nearly the same from 3 plats of spring-plowed land, one plowed 2, one 5, and one 10 inches deep. In 1890 land plowed 8 inches deep gave a little larger yield than that plowed shallower.

In 1891, for the first time in 4 years, there was a larger yield from a plat deep cultivated than from one shallow cultivated. A cultivator with narrow spring teeth was used this year in the deep cultivation, in former years a shovel cultivator. For 4 years the average yields have been at the rate of 71 bushels from deep and 76

from shallow cultivated plats, and 73 bushels from plats not cultivated except to remove weeds by scraping the surface with a hoe.

No appreciable effect on yield of field corn resulted from cutting the tops when in good condition for fodder, or from removing the tassels from alternate rows as they appeared.

Experiments made for 3 years illustrate the fact that there is relatively little dry matter in corn during the early stages of its growth. When it had reached half of its height it had not more than 7, in full tassel less than 50, and when in the soft milk stage less than 75 per cent as much dry matter as when fully mature. Unless there is loss by dropping of leaves the dry matter increases until the corn is mature.

Indiana Station, Bulletin No. 39, April, 1892 (pp. 30).

FIELD EXPERIMENTS WITH CORN, W. C. LATTA, M. S. (pp. 33–43).—A condensed account of experiments in continuation of those reported in Bulletin No. 23 of the station (see Experiment Station Record, vol. I, p. 37). The following subjects are treated: (1) Early and late planting; (2) thick and thin planting; (3) deep and shallow plowing; (4) deep and shallow cultivation; (5) test of corn cultivators; (6) rotation *vs.* continuous cropping; (7) effect of previous manuring; (8) full *vs.* partial applications of fertilizers; (9) test of varieties. "The soil of the station farm is a compact, dark-colored second bottom, containing a large proportion of clay intimately mixed with vegetable matter, and underlaid with coarse gravel. Though highly retentive of capillary moisture, the perfect natural drainage, due to the underlying gravel, prevents an accumulation of free water in the soil. Owing to this fact, a protracted drouth in July and August neutralizes in large measure the effects of fertilization and methods of culture, and seriously reduces the yield of corn." The plats varied in size from one tenth to one fourth of an acre.

Early and late planting.—The yields for 3 years (1888–90) from planting at 5 different dates from May 1 to 29, are tabulated. The largest average yield was from the earliest planting.

Thick and thin planting.—The yields for 6 years (1885–91, omitting 1887) from planting at 5 different distances (10.75 to 19.5 inches apart in the row), are tabulated. "The best average results were obtained when the kernels were dropped 12 to 14 inches apart."

Deep and shallow plowing.—The yields in 1891 from plowing to five different depths (4 to 12 inches) are tabulated, together with those in 3 previous years from plowing to depths of 4 and 8 inches. The variations in yields were too small to be decisive.

Deep and shallow cultivation.—The yields for 4 years (1888–91) from cultivating to three different depths (1–3 inches) are tabulated. The largest average yield was from shallow cultivation (1 inch).

Test of corn cultivators.—An account of a test in 1891 with six different kinds of implements, three of which had also been tested during 3 previous years. "Those corn cultivators which run shallow, but thoroughly pulverize the soil and leave the surface approximately level, have given the best satisfaction."

Rotation vs. continuous cropping.—The yields during 4 years (1888–91) are tabulated from plats on which continuous cropping of corn has been compared with rotation of that crop with grass and clover. No fertilizers have been applied. The average results show a gain of 3 bushels of corn per acre from rotation. For lack of fertilizers the yields under both systems have steadily declined.

Effect of previous manuring.—"In 1883 and 1884 fresh horse manure, gas lime, and superphosphate were applied separately to certain plats on which corn had been grown every year since 1879. The amounts applied per acre in the 2 years were, horse manure 69 two-horse loads; gas lime and superphosphate 500 pounds each. Since the first application of fertilizers and manure, in the spring of 1883, nine crops of corn have been grown." The results, as summarized, show that with gas lime and superphosphate, respectively, there has been an average decrease of 0.44 and 1.76 bushels per acre in the yield of corn, but that the horse manure has given an average increase of 12.64 bushels. In 1891 the plats on which the horse manure had been applied yielded nearly 9 bushels more than the unmanured plats.

Full vs. partial applications of fertilizers.—As indicated by the average yields of corn during 2 years in an experiment in which full and partial applications of fertilizers and horse manure were compared with no manure, amounts of either commercial fertilizers or manure supplying about two thirds as much nitrogen, phosphoric acid, and potash as a full crop (50 bushels per acre) would require, will give fully as good results as a full application. Manure gave larger yields than commercial fertilizers.

Test of varieties.—A table gives the date of ripening, yield of corn and stalks, and percentages of ears, shelled corn, shrinkage in curing, and barren and smutted stalks for 22 varieties grown at the station during from 2 to 5 years.

The table shows (1) a range of 28 days in the time of ripening; (2) a range, in yield per acre, of nearly 35 bushels of corn and almost 700 pounds of stalks; (3) a range of from 27.5 to 52.5 per cent in the proportion of ears to 100 pounds of stalks and ears; (4) a difference of nearly 4 per cent in the proportion of shelled corn to weight of ears; (5) a marked range in the amount of shrinkage—from 3.2 to 23 per cent; (6) striking differences in the per cent of smutted stalks, the range being from 6 to 24 per cent; (7) very great differences in the per cent of smutted stalks that did not produce ears, the range being from nothing to 50 per cent.

SUGAR BEET CULTURE IN INDIANA, H. A. HUSTON, M. A. (pp. 44–53, plate 1).—A report on experiments in growing sugar beets in Indiana, in continuation of those recorded in Bulletin No. 34 of the station (see Experiment Station Record, vol. II, p. 635). Tabulated data are given showing the results of analyses and the conditions of culture for 65 samples grown by 39 persons in different parts of Indiana and for 66 samples grown at the station. Of the beets grown at the station 41 samples gave over 12 per cent of sugar in the juice, the highest being 15.1 per cent; of those grown elsewhere, 41 gave over 12 per

cent, the highest being 17.7 per cent. On the whole the results are considered sufficiently favorable to warrant the continuation of experiments in this line.

DISEASES OF THE SUGAR BEET ROOT, J. C. ARTHUR, D. SC., AND K. E. GOLDEN, B. S. (pp. 51–62, plate 1).—A report on observations on three diseases of the beet root, viz, a bacterial disease, beet scab, and water core spots.

A bacterial disease of beet roots.—Late in the season of 1890 microscopic examinations made at the station revealed the presence of bacteria in beets having a low percentage of sugar. More extended observations during the following year showed that beets of different varieties grown in different parts of Indiana were quite generally affected by the same disease. Analyses showed that the diseased beets contained much less sugar than the healthy roots.

The beet root shows externally no marks by which the presence of the bacterial parasite can be detected; the most diseased and the strictly healthy roots can not be separated by any external characters. This statement, however, does not apply to the leaves. While the plants are small the foliage of healthy and diseased plants remains normal, but as the plants reach full size, and especially as they approach maturity, those which are most affected can be told at a glance by the altered appearance of the leaves. The healthy beet leaf has a decidedly flat, uniform surface, while the diseased leaf is puffed out between the veins in little blister-like areas, giving the general appearance of the surface of a Savoy cabbage leaf. Diseased plants are necessarily less vigorous than healthy ones, and the fact is made apparent to the eye as the season advances by the leaves becoming paler and smaller, and the outer ones dying away faster than those upon healthy plants. All these indications taken together, most reliance being placed upon the crinkled surface, will enable one to select such diseased plants, as they are growing in the field, with considerable certainty. But some roots not showing the foliar characteristics to any marked extent will also be found to be affected.

Upon cutting across a root the most constant indication of the malady is a greater prominence of the fibers which form the concentric rings. In well-marked cases each microscopic bundle shows as a dark dot, the circles of dots growing more distinct upon exposure to air. In less pronounced cases the woody fibers are merely yellowish or even quite colorless, but become more prominent than normal tissues after being exposed to the air for a while. Furthermore, the diseased root is rather soft and tough and of a yellowish white color, while a healthy root is firm, somewhat brittle, and clean white in color. It has also been found that diseased roots are lighter in weight than healthy ones. * * *

While the bacteria are most abundant and conspicuous in the colorless parenchyma, they also occur in the cells of the fibro-vascular bundles, and in the green cells of the leaf—in fact in all parts of the plant.

The bacteria are all of one shape and appearance, being nearly twice as long as broad, small, oblong, colorless, usually occurring as isolated cells, although occasionally found in pairs.

Pure cultures have been studied in the laboratory, being isolated by the well-known plate method. The separation is easily accomplished, as the large size of the roots permits the removal of pieces of tissue from well below the surface, and consequently free from soil and air contamination, and from such material only one form of microbe is obtained.

In a Pasteur sugar culture the bacteria grow well, causing the liquid to become slightly turbid in 24 hours. As growth goes on the turbidity becomes greater, and

again decreases until at the end of 9 or 10 days, when the growth practically ceases, the liquid becomes clear, and a grayish sediment falls to the bottom of the tube.

The bacteria also develop well in sterilized juice expressed from the sugar beet, but their development can not be readily watched, as contact with the air causes the juice to turn very dark or even black.

Upon neutral gelatin the bacteria at first form a whitish growth, which becomes pale yellow with age, and the gelatin is eventually liquefied. Upon acid gelatin the liquefaction proceeds much more slowly. In all cases the gelatin finally becomes alkaline, whether acid or neutral to begin with.

Upon agar-agar the growth is about the same as upon acid gelatin, but of course without liquefaction of the substratum.

Inoculation with pure cultures into the beet root has been attempted, and results appear to show that the disease was transmitted, but the trials were few, and we desire to repeat them before further discussing this part of the subject. * * *

The present state of our knowledge does not permit us to say how the bacteria gain access to the interior of the beet as it grows naturally in the field.

Beet scab.—In 1891 the authors observed scab on beets and found that it was caused by the potato scab fungus (*Oöspora scabies*). This is in agreement with the independent observations by H. L. Bolley, M. S., reported in Bulletin No. 4 of the North Dakota Station (see Experiment Station Record, vol. III, p. 619):

The scab has been transmitted directly from the potato to the beet by experiments made in a cool greenhouse. On February 19, 1892, a young potato tuber, just removed from a pot-grown plant and well covered with active scab, was laid in contact with a perfectly healthy root of a young beet not more than a half inch in diameter. An examination was made 8 days later, but with no distinct evidence of results. On March 28 the beet showed a well-defined scab about a quarter of an inch across, where the diseased potato touched it, and no trace of scab elsewhere. This result is so decisive and clear that other tests need not be detailed in this connection.

Pure cultures of the scab fungus made in nutrient solutions show that the organism itself is perfectly colorless, but that it excretes some substance which in the presence of oxygen becomes dark brown. Cultures have been made in the fermentation tubes brought out by Dr. Theobald Smith, which are so constructed that one arm of the tube remains free of all gases. In such a tube the part of the culture in contact with the air becomes a deep brown color and that in the opposite gas-free portion remains uncolored for even a month or more, and its final change to brown, if the culture is continued sufficiently long, is without doubt due to diffusion both of the gas absorbed from the air and of the oxidized substance, by which they pass from the open arm of the tube into the closed arm.

The scab fungus produces a stronger reactionary effect upon the beet than upon the potato. The scabs of the beet are not only of greater areas, but also thicker. The thickness is chiefly built up of an abnormal growth of delicate cork cells, and may exceed even a quarter of an inch. As a rule it is chiefly the surface of this spongy growth that takes on the brown color. * * *

In a few instances the colored excretion penetrates to unusual depths, and beets are occasionally cut open having several of the concentric annular layers of tissue beneath a scab spot colored a reddish brown. Such discolorations may sometimes extend some inches in all directions. It is supposed that these stains are due to some peculiar condition of the root, which permits a greater diffusion of the excretion of the organism than usual.

A few instances of a blackish staining of the internal parenchymatous tissues of the root have been noted. These differ from the last chiefly in color, in being deeper seated as a rule, and in having no apparent connection with scab spots upon the

surface of the root. The stained areas are of considerable extent, and, as in the former case, gradually blend with the normal colorless tissue. The origin of these blackish stains is undoubtedly entirely distinct from that of the reddish or scab stains; and attention is called to them in this connection in order to invite further study.

The scabs which arise before the beet is full grown may sometimes be checked in their development, and in some cases may entirely disappear, except to leave a more or less clean, well-marked scar. Such scars are generally somewhat sunken, and of definite outline. * * *

The scab is well distributed in this State, being received from various sections, and also occurring upon the station grounds. It is also common in North Dakota, and has been detected in a few instances in Iowa [as reported in Bulletin No. 15 of the Iowa Station (see Experiment Station Record, vol. III, p. 783)].

Water core spots.—The spots usually occur in the parenchymatous tissue between the fibrous rings. They are generally sharply defined, and do not grade into the adjoining tissues. They are colorless or of a pale yellowish tint, and turn black upon immersion in alcohol, the rest of the beet remaining colorless. In size they range from that of a pin head to a half inch across, but are most commonly the size and shape of a pea. While usually rounded masses, they may sometimes become quite elongated in the direction of the axis of the root, and are rarely irregular in form.

The spots are entirely composed of parenchyma tissue, the cells of which have thin walls and are apparently without vacuoles. A prominent nucleus with large nucleolus occupies the center of the cell. The cells measure, in the specimens examined, 0.03 to 0.075 mm. in diameter, while the cells of the adjoining parenchyma measure 0.15 to 0.25 mm. in diameter, the measurements being taken in transverse sections of the root.

Sometimes there are but one or two such spots in a root, but more usually there are several, and in rare cases a dozen or more.

There appears to be no parasitic organism, either animal or vegetable, associated with them, and no explanation of their presence can be suggested.

Kansas Station, Bulletin No. 30, December, 1891 (pp. 26).

FIELD EXPERIMENTS WITH CORN, C. C. GEORGESON, M. S., F. C. BURTIS, B. S., AND W. SHELTON (pp. 181–207).—The experiments of 1891 reported in this bulletin include the following subjects: (1) Frequency of cultivation; (2) time of harvesting for grain and fodder; (3) large *vs.* small kernels for seed; (4) butt, middle, and tip kernels for seed; (5) distance of planting for grain and fodder; (6) distance of planting for silage; (7) removal of tassels; (8) plaster and oil meal as fertilizers; (9) treatment of seed corn with creosote for smut; (10) test of varieties. Previous experiments with corn were reported in the Annual Reports of the station for 1888 and 1889 (see Experiment Station Bulletin No. 2, part II, p. 13, and Experiment Station Record, vol. II, p. 334). In 1891 the meteorological conditions were favorable to the growth of corn. Except in three cases the corn was grown on clay loam soil. The planting was done May 10–15. Except in the test of varieties, the corn was planted in rows 3.5 feet apart, and the plants thinned to 16 inches apart in the rows.

Frequency of cultivating (pp. 183, 184).—Notes and tabulated data on an experiment with St. Charles corn on 30 twentieth-acre plats

divided into two series of 15 plats each. "Series A had 5 plats cultivated twice a week, 5 plats once a week, and the remaining 5 once in 2 weeks. The three 5-plat groups in series B were cultivated, respectively, two, four, and six times during the season. The implement used was the Daisy spring-tooth cultivator." The average yields in bushels per acre were as follows: Twice a week, 66.63; once a week, 69.45; once in 2 weeks, 72.97; twice during the season, 68.02; four times during the season, 76.06; six times during the season, 70.08. "The highest yields attained in both series, viz, 72.97 bushels per acre when cultivated once in 2 weeks, and 76.06 bushels per acre when cultivated four times during the season, is the result of what is practically the same amount of cultivation. * * * If this experiment, then, proves anything, it is that in a wet season like the last, and on soil of the character here employed, it is possible to give corn too much as well as too little culture."

Time of harvesting for grain and fodder (pp. 184–186).—Notes and tabulated data on an experiment with St. Charles corn on 20 twentieth-acre plats divided into four groups of 5 plats each. The corn was cut (1) in milk, August 20; (2) in dough, August 28; (3) ripe, September 18; or (4) was left standing until husked. The average results were as follows:

Effect of time of harvesting on yield of corn.

Time of harvesting.	Average yield per plat.		Yield per acre.		Percentage less than yield when ripe.	
	Grain.	Fodder.	Grain.	Fodder.	Grain.	Fodder.
	Pounds.	*Pounds.*	*Bushels.*	*Tons.*		
Cut in milk	124.5	244.1	35.56	2.44	51.9	10.5
Cut in dough	178.8	242.9	51.08	2.43	30.9	11.0
Cut when ripe	258.9	273.0	73.96	2.73	0.0	0.0
Not cut	255.6	....	73.02	....	1.2	....

These results confirm those of similar experiments reported in the Annual Reports of the station for 1888 and 1889.

The present experiment, however, varies from those there reported on one point, which possibly may be due to the intrinsic characters of the varieties employed. It was then found that there was a gain of from 10 to 12 per cent in the weight of corn (ears) by letting it stand uncut in the field until husked, over that which was cut when ripe. The present experiment with St. Charles corn does not bear out that result. In fact it is found, as shown in the table, that there is a slight loss this year by letting it stand, aside from the inevitable loss both in quantity and quality of the fodder.

The general results obtained at this station are confirmed by similar experiments at the Pennsylvania Station, as published in the Annual Report of that station for 1890 [see Experiment Station Record, vol. III, p. 713]. It was there found that there was a total loss of 40.62 per cent of dry matter in the entire corn plant by cutting it when the grain began to glaze instead of allowing it to ripen.

Large vs. small kernels for seed (p. 187).—Notes and tabulated data on an experiment with St. Charles corn on 10 twentieth-acre plats. "Practically the yield was the same whether large or small kernels were used for seed."

Butt, middle, and tip kernels for seed (pp. 187, 188).—Notes and tabulated data on an experiment with St. Charles corn on 15 twentieth-acre plats divided into three groups of 5 each. "The butt and tip kernels were taken from the extreme ends of the ears and only deformed but sound kernels used. The middle kernels were the largest and best from the middle of the ears." The average yields in bushels per acre were as follows: Butt 66.11, middle 62.51, tip 61.14. In experiments with a flint variety at New York State Station some years ago seeds from the tips gave the best results.

Distance of planting for grain and fodder (pp. 188–197).—This was an experiment on 240 plats, each 60 feet long and 4 rows wide. "The rows differed in width from 1.5 to 4 feet, and the distance between the stalks in the rows from 4 to 20 inches." In some cases the corn was surface planted and in others it was listed. The soil used was comparatively exhausted, having been in corn for many successive years. Three varieties were used, each on duplicate plats, so that there were six repetitions of the same distances of planting, two for each variety.

St. Charles corn is a white, late-maturing variety; Leaming a yellow, medium-maturing variety; and Pride of the North an early yellow variety. Each may be taken as a type of a class of varieties which find more or less favor in various sections of the State. * * *

Pride of the North ripened by the middle of August. It was cut and shocked August 29. Leaming was cut and shocked August 31, when it was ripe, and St. Charles was cut and shocked September 14.

[The results are reported in detail in tables]. On this soil it was found that small to medium sorts, like Pride of the North, yield best when the rows are 3 feet apart and the stalks 16 inches apart in the row; Leaming about the same, though the best yield of merchantable corn was reached when the rows were 3.5 feet apart and the stalks 20 inches in the row. St. Charles gave the best yield of merchantable corn when the rows were 3 feet and the stalks 20 inches apart. Listed, the best yields were obtained when the rows were 4 feet apart and the stalks 8, 12, and 16 inches apart for Pride of the North, Leaming, and St. Charles, respectively, and the best yields of merchantable corn when the stalks were 4 inches farther apart, in each case. In general, corn grown from the grain should not be planted closer than 3 feet nor farther than 3.5 feet between the rows, and the stalks should be from 16 to 20 inches apart for medium varieties surface planted. The highest weights of fodder were obtained when the stalks were but 4 inches apart in the row.

Distance of planting for silage (pp. 197–200).—Notes and tabulated data on an experiment with a large Southern variety of white corn on 44 plats, each 150 feet long and containing 4 rows. "The rows varied from 1.5 to 3.5 feet apart, increasing by a half foot, and the stalks in the rows from 4 to 16 inches, increasing by 4 inches in different plats." On 4 plats the corn was listed, on the others it was surface planted. The land used was a clay loam of even quality, which had been in silage corn for several years.

September 19–22, when the grain was in the soft dough state, 100 pounds of green corn were cut from each plat, and the percentages of ears, leaves, and stalks determined. The crop for the whole plat was afterwards cut, weighed, and put into the silo. "The heaviest weight

of food material for silage (leaves and ears) was obtained when the rows were 3.5 feet apart and the stalks 4 inches apart in the row. Next to this the best results were reached when the rows were 3 feet apart and the stalks from 12 to 16 inches, or the rows 3.5 feet and the stalks 8 to 12 inches, with but little choice between them."

Removal of tassels (pp. 200, 201).—Notes and tabulated data on an experiment with St. Charles corn on 12 small plats, each containing 5 rows 3.5 feet apart. The plats were located in the midst of corn fields, so that there was no lack of pollen to fertilize the detasseled rows. The tassels were removed from day to day as they appeared. The results are summed up as follows:

Total weight of ears from rows with tassels removed ....pounds..	1,133.50
Total number of ears from rows with tassels removed	1,782.00
Average weight per ear from rows with tassels removed ....pound..	0.64
Total weight of ears from rows with tassels remaining ....pounds..	663.00
Total number of ears from rows with tassels remaining	1,108.00
Average weight per ear from rows with tassels remaining ....pound..	0.60
Yield per acre, tassels removed ....bushels..	107.90
Yield per acre, tassels remaining ....do....	94.70
In favor of removing tassels ....bushels..	13.20

Plaster and oil meal as fertilizers (pp. 201, 202).—Plaster and castor bean pomace were each applied at the rate of 200 pounds per acre on a considerable number of plats and were compared with no manure. Neither of the fertilizers had any effect on the yield.

Treatment of seed corn with creosote for smut (pp. 202, 203).—St. Charles corn was soaked for 12 hours before planting in solutions containing from 0.5 to 50 per cent of creosote. Only where the weakest solution was used did any of the corn germinate, and in that case the percentage of seed germinating was only 55. Even when a 0.1 per cent solution was used the yield was materially reduced.

Test of varieties (pp. 203–206).—Tabulated data for 140 varieties. The following gave the best results in the order named: Mammoth White Dent, Hartman Early White, Silver Mammoth Yellow, Mammoth Ivory Dent, North Star, Piasa Queen, Leaming, Pride of Kansas, Legal Tender, and Large Golden Dent, the yields ranging from 80 to 91 bushels per acre. Those found to be excellent silage varieties were Hiawasse Mammoth, Little Red Cob, Mosby Prolific, and Parrish White.

Kansas Station, Bulletin No. 31, December, 1891 (pp. 17).

SUGAR BEETS IN KANSAS, G. H. FAILYER, M. S., AND J. T. WILLARD, M. S. (pp. 209–223).—An account is given of the arrangements made by the station for a test of sugar beets of different varieties by about 360 farmers in 56 counties of the State. Analyses of a large number of samples sent to the station and of beets grown at the station

are tabulated, together with data regarding culture. Climatic conditions rendered the test unsatisfactory, the sugar content being in most cases relatively low. The test will be repeated.

A few words in reference to our machine for pulping the beets may not be amiss. Taking a worn-out feed mill as the basis, we removed superfluous parts, leaving a short shaft in its bearings and carrying a heavy fly-wheel. A crank handle was attached to the fly-wheel near the shaft. A wooden pulley, such as is used for belts, was attached to the middle of the shaft. This pulley was 4 inches wide and 18 inches in diameter. Ten lines of tacks were driven into the pulley, each line running diagonally across its width. The angle of the lines and the distance between them was such that the successive lines lapped past each other slightly. The tacks in the lines were set close together and were slightly sharpened with a file on the front edge. They projected about the sixteenth of an inch. The pulley was inclosed in a suitable case of galvanized iron, the top of which could be removed and the bottom of which had an opening through which the pulp dropped. An opening was also left through which the beets were fed. The beets during grinding rested on a board which was placed as close to the pulley as possible. The beets were held by hand against the revolving pulley, the board giving a safe rest, so that there was no danger of accident. The crank handle being near the shaft, a much higher rate of speed was given to the periphery of the pulley than would have been possible with a longer lever arm. The beets pulped easily, and the only drawback was the rapid rate of turning demanded. Some multiplying arrangement to secure the necessary motion would be a great advantage. When run by steam power the cutter worked to perfection, pulping rapidly and very fine. * * *

To illustrate the difference in nutritive value of certain roots and to compare them with sugar beets, the following analyses are given. They are all analyses of fresh material grown at this station:

Analyses of root crops.

	Water.	Dry matter.	Crude ash.	Crude fat.	Crude protein.	Crude fiber.	Nitrogen free extract.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Garden beets (red)	92.89	7.11	1.14	0.04	1.95	0.71	3.27
Turnips	92.71	7.29	0.90	0.06	2.04	0.82	3.47
Kohl-rabi	91.25	8.75	1.29	0.08	1.71	1.43	4.24
Ruta-bagas	89.99	10.01	0.69	0.10	2.03	1.09	6.10
Sugar beets (Klein Wanzleben 1890, 10.3 percent sugar)	84.04	15.96	0.77	0.03	1.76	0.95	12.45

Kentucky Station, Second Annual Report, 1889 (pp. 150).

This includes a financial report for the fiscal year ending June 30, 1889; brief statements regarding the organization, equipment, and work of the station; notes on injurious insects and fungi; and reprints of Bulletins Nos. 17–22 of the station (see Experiment Station Record, vol. I, pp. 62, 63, 218, and 219).

INJURIOUS INSECTS AND FUNGI, H. GARMAN (pp. 8–51, figs. 17).—Brief accounts of injury in Kentucky in 1889 by the grain louse (*Siphonophora avenæ*), cabbage worms (*Pieris rapæ* and *P. protodice*), corn worm (*Heliothis armigera*), and ox warble; and notes on the following insects and fungi, with special reference to observations by the

author, and suggestions regarding means of repression: Corn leaf hopper (*Tettigonia mollipes*), wheat thrips (*Limothrips cerealium*), wheat bulb worm (*Meromyza americana*), clover bark louse (*Coccus trifolii*), ox warble (*Hypoderma bovis*), cabbage flea beetle (*Phyllotreta vittata*), potato flea beetle (*Crepidodera fuscula*), pig-weed flea beetle (*Disonyca glabrata*), tobacco flea beetle (*Epitrix parvula*), brown rot of stone fruits (*Monilia fructigena*), bitter rot of apples (*Glœosporium versicolor*), apple scab (*Fusicladium dendriticum*), and black rot of tomatoes. A number of the figures accompanying the text are original. Spraying experiments are reported for brown rot with potassium sulphide (1, 2, and 4 per cent solutions), carbolic acid (1 per cent), copper sulphate (2 per cent), iron sulphate (2.5 and 5 per cent), potassium sulphate (5 and 10 per cent), Bordeaux mixture and hyposulphite of soda (1 pound to 10 gallons of water). Bordeaux mixture and potassium sulphide (1 per cent) were the most effective remedies.

Louisiana Stations, Fourth Annual Report, 1891 (pp. 22).

Brief accounts are given of the work of the three stations in different lines, together with a financial statement for the fiscal year ending June 30, 1891.

REPORT OF DIRECTOR, W. C. STUBBS, PH. D.—*Experiments with cotton.*—Notes and tabulated data are given for experiments in planting at different distances and for a test of varieties at the Sugar Experiment Station. Sea island cotton planted in rows 7 feet apart at distances in the rows of from 6 inches to 5 feet gave the largest yields of seed cotton at from 6 inches to 2 feet. The yields of 12 varieties of cotton in 1890, a wet season, are compared with those of 1891, a dry season. In the former year Boyd Prolific and Allen Long Staple gave the largest yields of seed cotton, in the latter year Peerless and Peelers. Innocent, an Egyptian variety grown at the station for the first time in 1891, gave a small yield. Perennial Peruvian cotton grew to a height of 12 feet, but produced neither square nor boll.

Experiments with corn.—The yields of 18 varieties are tabulated; Mosby Prolific, Improved Leaming, Mastodon, and Golden Beauty gave the largest yields.

Fruits.—Lists of varieties of pears, plums, pomegranates, figs, citrons, shaddocks, pomelos, cumquat, limes, lemons, oranges, tangerines, and mandarins planted at the Sugar Experiment Station.

Forage plants.—Brief notes on a number of different kinds, including 93 species of grasses. Teosinte, alfalfa, *Medicago media*, German millet, red clover, crimson clover, *Vicia villosa*, *V. sativa*, *Agrostis vulgaris*, *Anthoxanthum odoratum*, *Arrhenatherum avenaceum*, *Andropogon annulatus*, *Bromus schraderi*, *Chloris schwartziana*, *Dactylis glomerata*, *Lolium italicum*, *Panicum frumentaceum*, *P. miliaceum*, and *Poa arachnifera* are promising.

Irrigation.—Successful experiments in surface and sub-irrigation have been made with sugar cane, sorghum, corn, cotton, and cowpeas. Work in this line will be continued.

Sugar school.—A school for the training of experts in sugar culture and manufacture has been established at the Sugar Experiment Station by the Louisiana Scientific and Agricultural Association.

Tobacco culture.—An expert has been employed to conduct experiments in tobacco growing and curing at the North Louisiana Station.

Soil investigations.—The systematic collection and analysis of the soils of the State have been undertaken with a view to preparing an agricultural map.

Louisiana Stations, Bulletin No. 14 (Second Series), (pp. 60).

SUGAR CANE, FIELD AND LABORATORY RESULTS, W. C. STUBBS, PH. D. (pp. 346–404).—The work here reported was in many instances in continuation of that reported in Bulletins Nos. 20 and 6 (second series) of the station (see Experiment Station Record, vol. I, p. 63, and vol. II, p. 569).

Weather synopsis (pp. 346–352).—A summary of meteorological observations from March 1, 1886, to December 30, 1891.

Taking the table and the seasons, we find that a dry, warm winter, followed by a moderately dry spring, and this in turn succeeded by a hot, wet summer, are conditions favorable to maximum growth of cane. It seems too that a dry, cool autumn, beginning early in September, is necessary to produce a large sugar content.

After the cane is laid by, frequent showers of considerable intensity appear highly beneficial, and if not supplied the crop will not reach the maximum tonnage.

Stripping cane (pp. 353, 354).—An experiment was tried on six rows, of stripping the dead leaves from the cane several times during the season, as is practiced in tropical countries. Alternate rows were stripped of all dead leaves on September 7, the others being left untouched. The tabulated analyses of the stripped and unstripped cane show that "the cane which remained almost naked for months failed to give as much sucrose as that untouched."

Irrigation (pp. 354–359).—A trial of irrigation, which was made incidentally on 7 plats of sugar cane, gave good results. "It is impossible to draw from these experiments the exact increment produced in our crops by irrigation. Enough is known, however, to justify the assertion that the profits of irrigation were very large in tonnage. This has been done without the sacrifice of the sugar content of the cane."

Distance between cane rows (pp. 360–366).—In 1890 striped cane was cultivated in rows 3, 4, 5, 6, 7, and 8 feet apart, the rows being 105 feet long, and 3 rows in each case being the same width. In 1891 these experiments were repeated on a large number of plats growing both striped and purple cane. The results of the experiments of both years are tabulated. Both years the 3-foot rows led in tonnage, being followed by the 4 and 5-foot rows, indicating "that the narrower the

row the greater the tonnage." The sucrose, purity coefficient, and percentage of sugar per ton of cane were "inversely as the widths of the rows."

Part of the cane to plant (pp. 366-368).—In 1890 selected stalks of cane were cut into two and three parts, that is tops, middles, and butts, and used for seed, and the observations were extended to the stubble in the following year. The results are tabulated for each year. "It is apparent that the part of the cane used for seed has little or no effect on the stubble. The effect seems to be entirely with the first year."

Number of stalks to plant (pp. 368-372).—In 1890 plats were planted with from 1 to 4 stalks, both cut and uncut, and in 1891 the observations were extended to the stubble. The results of the 2 years' trial are tabulated. In 1890 the indications were "that cutting cane should be avoided as far as possible, and the knife used only to secure horizontal position for the cane." The stubble showed in 1891 very little effect from the cutting.

The difference in the "cut" and "uncut" experiments in 1890 was 13.68 tons per acre; in 1891 it was only 1.08, showing that evil effects of the knife had been nearly, if not entirely, overcome in the stubble. The continuance of these experiments emphasizes the suggestions of last year, viz, that one good, sound cane with a lap, properly planted, may give excellent results, while more than two is a waste and extravagance to be severely reproved, and that the knife should be used as little as possible in the planting of cane.

Plant vs. stubble cane for seed (p. 372).—The experiments on this question were considerably interfered with and the results, being considered unreliable, are not tabulated.

Varieties of cane (pp. 372-383).—Tabulated and descriptive notes are given for a large number of foreign canes tested at the station.

Fertilizers for sugar cane (pp. 384-394).—On three series of plats potash fertilizers (kainit, sulphate and muriate of potash, cotton-hull ashes, and nitrate of potash), phosphoric acid fertilizers (dissolved boneblack, acid phosphate, boneblack, bone meal, South Carolina floats, and Thomas slag), and nitrogenous fertilizers (cotton-seed meal, dried blood, sulphate of ammonia, tankage, and fish scrap) were applied in various amounts and combinations. The tabulated results "have failed to throw any light upon the kind of fertilizers required to give us high sugar content in our canes."

Nearly every form of nitrogen alone has given increased yields over the unfertilized plats—in some instances over 5 tons per acre and averaging 2.5. The combination of cotton-seed meal with mixed minerals alone has given constant increments in yield. Dried blood under similar conditions shows a loss. Sulphate of ammonia shows decided gains. The rest exhibit no gains by combination.

Only with sulphate of ammonia has the double ration been profitable. It is therefore apparent that nitrogenous manures alone have been productive of increased yields, averaging over 2.5 tons per acre, and when combined with mixed minerals have given 5.25 tons per acre over the unfertilized plats. The mixed minerals in this plat have, however, given very high results, and when the combinations

are compared with these little or no gains are perceptible. * * * It may be positively assumed that (1) these soils require nitrogen; (2) when properly combined with mineral manures nitrogen gives its best results; (3) while all forms have given increased yields, sulphate of ammonia and cotton-seed meal have given the largest.

Striped vs. purple cane (pp. 394–400).

To decide this question the station has this year made twelve duplicate experiments with each of the 2 varieties growing side by side. Four of each were unfertilized and eight were fertilized. They were also grown in rows of different widths. * * * The striped cane was worked up December 9 and the purple December 11, both having been previously killed by the frost of November 30, and left standing until used. Appearances in the field and work in the sugarhouse indicated no material injury from the frost. They were worked up separately and careful notes made during the entire process, from diffusion juice to sugar. No difference was discovered until reaching the centrifugal. They were cooked in the pan to about the same density, and yet on drying the striped showed marked superiority, both in time required and in sugar obtained. The purple gave a *masse cuite* which was far more difficult to centrifugal, and ultimately a lower grade sugar. This may have been due to some accidental imperfection of cooking, which sometimes occurs even with the best sugar makers, and not to any inherent property of the juice. Yet an inspection of our tables shows uniformly higher quantities of "solids-not-sugar" in the purple than in the striped. * * * It would seem from present investigation that the striped possessed more good qualities for southern Louisiana than the purple.

Composition of sugar cane at various stages of growth (pp. 400–404).—Analyses with reference to food constituents are given of the canes at time of planting; of the seed cane, young cane, and roots collected June 2 and July 14; and of the cane sampled September 25, when it had attained nearly its full growth, together with analyses of the ash of a sample collected September 25. The conclusions drawn by the author from the results are that—

(1) The mother cane supplies the young sprouts with albuminoids, fat, carbohydrates and (perhaps) ash in the earliest stages of its growth, and there arrives a time, perhaps as soon as the root system of the young plant is well developed, when these sprouts cease to draw on the mother cane for nourishment, and the latter remains thereafter nearly constant, except from decay.

(2) The composition of the cane plant varies greatly during growth. While young the percentages of ash, albuminoids, and fat are the greatest, decreasing until maturity, when they become least. The fiber and carbohydrates are small in the young plant, increasing with growth and reaching maxima at maturity.

One ton of cane delivered at the mill would remove from the soil 9.4 pounds of albuminoids or 1.5 pounds nitrogen, and 12.2 pounds of ash or mineral matter. This mineral matter would contain 2.17 pounds potash, 1.48 pounds phosphoric acid, and 0.8 pound lime.

Maryland Station, Special Bulletin F, January, 1892 (pp. 15).

THE AGRICULTURAL OUTLOOK FOR MARYLAND, E. STAKE.—An address delivered before the Maryland State Farmers' Association by its president and published by the station at the request of the Association.

Maryland Station, Special Bulletin G, February, 1892 (pp. 11).

INSPECTION AND ANALYSIS OF COMMERCIAL FERTILIZERS SOLD IN MARYLAND.—This includes analyses made at the Maryland Agricultural College of 57 samples of fertilizers received and collected in 1891, together with the trade values of fertilizing ingredients for 1891 and remarks on the valuation of fertilizers.

Massachusetts State Station, Circular, March, 1892 (pp. 8).

COMMERCIAL FERTILIZERS, C. A. GOESSMANN, PH. D.—This includes the trade values of fertilizing ingredients for 1892; remarks on the valuation of fertilizers; and instructions to manufacturers, importers, agents, and sellers of commercial fertilizers. Analyses are given of wood ashes, cotton-hull ashes, cotton-seed meal, wool waste, fish waste, ground meat scraps, and animal refuse.

Massachusetts Hatch Station, Bulletin No. 17, April, 1892 (pp. 37).

EXPERIMENTS WITH FUNGICIDES AND INSECTICIDES AND WITH ORCHARD FRUITS AND GRAPES, S. T. MAYNARD, B. S. (pp. 11–47, plates 11, figs. 4).—The following subjects are treated: (1) Experiments with fungicides and insecticides in 1891, (2) experiments with grapes and peaches, (3) the Siberian crab apple as a grafting stock, (4) girdling grapevines, (5) amount of copper on sprayed fruit, (6) plan for experiments with fungicides and insecticides in 1892, (7) spraying apparatus.

Experiments with fungicides and insecticides in 1891 (pp. 11–32).—Accounts of spraying experiments at the station and at several other places in Massachusetts with Bordeaux mixture, ammoniacal carbonate of copper, sulphate of copper, and sulphate of iron, alone and in combination with Paris green, principally for apple scab, pear leaf blight, plum leaf blight, peach and plum fruit rot, black knot of the plum, powdery mildew and black rot of grapes, raspberry anthracnose, and potato rot, and for the tent caterpillar, codling moth, and plum curculio.

J. Fisher reports experiments in which very weak solutions of sulphate of copper (1 pound to 800 or 1,000 gallons of water) were used on grapes and tomatoes, and others in which kerosene emulsion proved an effective remedy for the pear tree psylla (*Psylla pyri*).

The results of the season's work are summed up as follows:

> The apple scab, pear leaf blight and cracking of the fruit, peach and plum fruit rot, plum leaf blight and plum black wart, grape powdery mildew and black rot, raspberry anthracnose, and potato leaf blight and rot may be wholly or largely prevented when the solutions of copper are properly applied.
>
> By the combined use of the Bordeaux mixture and Paris green the above fungi are prevented, the tent caterpillars and cankerworms are killed, and the injury to the apple and pear from the codling moth and to the plum and peach by the plum curculio may be largely prevented.

If the spores of the plum wart become established in the tree, the copper solutions do not stop their growth, but by painting with "kerosene paste" they are destroyed at once.

The peach foliage is very susceptible to injury from copper solutions, which must, therefore, be applied at from one third to one fourth the strength used upon the apple and pear.

Experiments with grapes and peaches (pp. 32–36).—Of 120 varieties of grapes grown in the station vineyard, 105 fruited in 1891. Very few of the new varieties are found equal to the standard sorts for general purposes. Concord, Worden, Moore Early, Delaware, Brighton, and Lady are recommended for general planting in New England. Among new varieties, Berckmann, Lindley, Massasoit, Rochester, Salem, Wilder, and Winchell (Green Mountain) have shown themselves to be promising. Ten of the new varieties are briefly described.

To test the keeping qualities of the many kinds of grapes grown, small quantities of each were placed on trays and put into the fruit room about October 1. Those that showed the poorest keeping qualities were Ann Arbor, August Giant, Champion, Concord, Early Victor, Eaton, Hayes, Janesville, Lady, Martha, Moore Early, Nectar, Niagara, Pearl, Triumph, and Worden. Those keeping up to March 1 in fair condition were Berckmann, Iona, Jefferson, Moore Diamond, Prentis, Roger Nos. 3, 4, 9, 19, 28, 30, 33, 34, 39, 41, and 44, Salem, Vergennes, and Woodruff Red.

Of 18 varieties of peaches which fruited at the station in 1891, Coolidge, Old Mixon, and Stump—white fleshed varieties—and Crawford Late, Foster, Reeves Favorite, Wheatland, and Crosby (Excelsior)—yellow fleshed varieties—were the most productive.

Observations on peach buds showed "that the buds were largely destroyed before the middle of December and generally before the temperature had reached zero or a few degrees below. When it has reached from 15° to 20° below the buds have nearly all been killed." The per cent of buds of 16 varieties found killed March 1 during the past 3 years (1890–92), as tabulated, indicates considerable difference in the hardiness of different varieties.

Experiments during 4 years (1888–92) in protecting the buds by bending down the trees and covering them with mats (obtained from straw-hat factories) and other light material indicate that when the covering is not too heavy it prevents the destruction of the buds and that this treatment does not injure the trees.

The Siberian crab apple as a grafting stock (pp. 36, 37).—A brief report on an unsuccessful attempt to top-bud Siberian crab apple trees with the Williams Favorite apple. The results are illustrated.

Girdling grapevines (pp. 37, 38).—An account by J. Fisher of experiments in continuation of those reported in Bulletin No. 13 of the station (see Experiment Station Record, vol. III, p. 24). Data are given which indicate that girdling (in 1890) weakened the vines and reduced their productiveness the following season.

Amount of copper on sprayed fruit (pp. 38–41).—Chemical analysis of grapes sprayed with copper compounds showed the presence of only

0.002 per cent of oxide of copper in one case and not a trace of copper in another. The amount of copper on the surface of apples sprayed with Bordeaux mixture was at the rate of 0.0005 of an ounce per barrel of apples. Not a trace of arsenic was found, though the apples had been sprayed three times with Paris green before July 1.

Plan for experiments with fungicides and insecticides in 1892 (pp. 41–43).—Brief directions for the application of fungicides and insecticides to orchard and small fruits, and potatoes.

Spraying apparatus (pp. 44–47).—Illustrated accounts of apparatus tested at the station, including a pump attached to a cask, a knapsack pump, and a syringe sprayer devised by J. Fisher, and termed the "Hydrosprayer." The last named is described as follows:

> The barrel of the sprayer is 15 inches long; the piston has a stroke of 14 inches; the diameter is 1.75 inches, and it will hold somewhat more than a pint. The nozzle is pierced with ninety-nine holes, having a direction radiating from a point in the rear, the effect being to throw a spray 20 or more feet with a spread of 6 feet. The holes are of such a size that the spray is as fine as is compatible with the distance mentioned.

Massachusetts Hatch Station, Bulletin No. 18, April, 1892 (pp. 54).

SOIL TESTS WITH FERTILIZERS, W. P. BROOKS, B. S. (pp. 51–87).—Coöperative experiments were made in 1891 on 7 farms in the State, including the college farm, with fertilizers for potatoes, oats, and corn. In the majority of cases these were on land which had been used for 1 or 2 years previous for similar soil tests, and each plat received the same kind of fertilizers as in the previous tests. Each experiment included 1 acre, containing 15 twentieth-acre plats separated by unfertilized strips. Five plats remained unmanured; one received 160 pounds of lime; another 160 pounds of land plaster; another 5 cords of barnyard manure per acre; and on the remainder nitrate of soda 160 pounds, muriate of potash 160 pounds, and dissolved boneblack 320 pounds per acre were used singly and in combinations of two and all three. Meteorological observations were made in most cases. The results of the analyses of the fertilizers and barnyard manure used, and the yields are fully tabulated. In several instances suggestions are made as to the fertilizer mixtures most likely to prove beneficial on the soil in question.

Experiments with potatoes (pp. 56–75).—These were 5 in number. In every experiment except one, which gave no reliable indications, potash proved more beneficial than either phosphoric acid or nitrogen, and the indications were that the soils needed potash especially for this crop. In two cases this was a corroboration of the results of previous trials with corn. "The average net increase [with 5 cords of barnyard manure] is 77 bushels against 61.2 bushels for complete fertilizer. * * * Viewed from the standpoint either of profit or recovery of plant food applied to the soil, these results are less satisfactory than those with complete fertilizer."

The analyses which were made of 12 "special" potato manures, taken in connection with the results of these trials, lead the author to suggest that potash "should be relatively more abundant in fertilizers especially designed for this crop than is usually the case. The 12 special potato fertilizers contained on the average, nitrogen 3.4, phosphoric acid 10.69, and potash 6.36 per cent."

Experiments with oats (pp. 76–82).—Two of these were made, one being on the college farm. In both cases nitrate of soda proved especially beneficial to the crop. "It proves more useful than either phosphoric acid or potash, and gives less increase when used either with muriate of potash alone or with muriate of potash and phosphoric acid. Our experiments with oats, then, although limited in number, strongly indicate the advisability of applying a small quantity of nitrate of soda for this crop."

Experiments with corn (pp. 82–87).—In the two experiments with corn, nitrate of soda proved decidedly beneficial, in one case more so than any other material; in the other, potash seemed to be the element most needed, and this result bore out the conclusions of the 2 previous years.

THE USE OF MURIATE OF POTASH WITH MANURE FOR CORN, W. P. BROOKS, B. S. (pp. 87–89).—One acre of land was divided into 4 equal plats. Plats 1 and 3 received 6 cords of barnyard manure per acre, and plats 2 and 4, 3 cords of barnyard manure and 124 pounds of muriate of potash per acre. The yields of corn were as follows:

Yields of corn per acre.

Plat.	Manure per acre.	Yield per acre.	
		Shelled corn.	Stover.
		Bushels.	*Pounds.*
No. 1	6 cords barnyard manure	61.1	3,840
No. 2	3 cords barnyard manure, 124 pounds muriate of potash	57.2	3,780
No. 3	6 cords barnyard manure	61.5	3,800
No. 4	3 cords barnyard manure, 124 pounds muriate of potash	55.4	3,660

"These figures and comparisons show that the manure alone produced slightly the better crop, but estimating manure at \$5 per cord and muriate of potash at \$45 per ton, shelled corn at 65 cents per bushel and stover at \$5 per ton, we find that the manure and potash, although producing a slightly less valuable crop, gave a financial result nearly \$9 better than manure alone."

A comparison of the fertilizing ingredients applied in the manures and removed by the crops indicates that "the unexhausted manurial residue in the soil of plats 1 and 3 is worth more than in the soil of plats 2 and 4. It is proposed to continue this acre in a similar experiment for a series of years."

SPECIAL CORN FERTILIZERS VS. A FERTILIZER RICHER IN POTASH, W. P. BROOKS, B. S. (pp. 90–92).—One half acre of land, formerly in pasture, and on which millet had been grown in 1890, was divided into halves in 1891 and planted to corn. On one half 200 pounds of a mixed fertilizer was applied, containing the proportions of fertilizing ingredients found on the average to be contained in seven of the more commonly used special fertilizers for corn, and on the other half a fertilizer mixture furnishing less nitrogen and phosphoric acid, but nearly three times as much potash and costing nearly $3 per acre less than the first. The yields of corn and the financial results show that the crop was equally large from the second section (55 and 56 bushels per acre), and the net returns $4.21 per acre greater than from the first section. The economy of buying the crude materials and mixing the fertilizers at home, instead of buying ready-mixed special fertilizers is urged. The results of the trial strengthen the views with reference to the use of fertilizers for corn advanced in Bulletin No. 14 of the station (see Experiment Station Record, vol. III, p. 165), which are reprinted, together with formulas for mixtures for corn.

On another half acre the fertilizers used above were applied for millet.

The average of the "special corn fertilizers" costing within 4 cents of $3 more per acre, gave a crop worth at least (at current prices for common millet) $6.38 less per acre than the fertilizer richer in potash—a net advantage in favor of the latter fertilizer of $9.34. This result affords further evidence, therefore, of the correctness of my conclusion in regard to fertilizers. They are undoubtedly, as a rule, too poor in potash.

COMPARISON OF CORN AND MILLET AS GRAIN CROPS, W. P. BROOKS, B. S. (pp. 93, 94).—This is on the basis of the yield, as the analyses had not yet been completed. Experiments are in progress to compare meal from millet seed and from corn as food for milch cows.

For the present I desire simply to call attention to the fact that the millet has enormous cropping capacity. It gave us to the half acre 37.2 bushels of seed, weighing 47 pounds per bushel, while the corn gave us 30.6 bushels of shelled grain. The millet straw weighed 2,191 pounds; the corn stover (by no means as dry) 2,100 pounds. The millet straw chopped, crushed, moistened, and sprinkled with meal is readily eaten by both horses and cattle; but it does not appear to be equal to the corn stover in feeding value. The millet seed, as shown by the results of foreign analyses, appears to resemble oats very closely in composition. So far as our experience in feeding it has gone, the meal from it appears to equal corn meal in feeding value for milk production. The fertilizers, it will be remembered, were the same for the two crops. The labor cost considerably more for the millet than for the corn. * * *

Our seed was sown in drills 14 inches apart at the rate of about 2 quarts per acre. It was planted May 14, cut and stooked September 18, and threshed October 5 and 7.

COMPOSITION OF POTATOES AS AFFECTED BY FERTILIZERS, W. P. BROOKS, B. S. (pp. 94–97).—The results are tabulated of determinations of moisture and of starch in samples of the tubers for each plat in three of the soil tests with fertilizers for potatoes reported above.

The number of determinations made is insufficient, and the differences are too small to justify very positive conclusions; but our results indicate a favorable effect of nitrate of soda and the dissolved boneblack upon the quality, for where these fertilizers are used the average of moisture is lower and that of starch higher than either the general average, the average of the nothings, the average of plats where other fertilizers were used, or the average of plats where manure was used.

The influence of muriate of potash appears to have been decidedly unfavorable to starch formation. Where it was employed the average per cent of starch is lower than under any other treatment.

REPORTS OF TRIALS OF MISCELLANEOUS CROPS, W. P. BROOKS, B. S. (pp. 97–104).—These include notes on 2 varieties of oats, 2 of millet, 2 of hemp, 3 of flax, several of wheat, and 7 of Japanese beans, with descriptions of some of the uses of the last named and analyses of the Red Adzuki bean (*Phaseolus radiatus*), the soja bean, and the common kidney bean (*Phaseolus vulgaris*). The analyses are as follows:

Percentage composition of beans.

	Kidney bean.*	Red Adzuki.	Soja bean.
Water	13.00	14.82	11.53
Crude ash	3.56	3.74	6.55
Crude protein	19.75	20.23	34.49
Crude fat	1.22	0.75	16.45
Crude fiber	62.27	3.83	4.40
Nitrogen-free extract		56.63	26.58
	100.00	100.00	100.00

* Analysis "according to Anderson."

Experiments are in progress at the station to test the feeding value of meal from soja beans.

Massachusetts Hatch Station, Bulletin No. 19, May, 1892 (pp. 35).

REPORTS ON INSECTS, C. H. FERNALD, PH. D. (pp. 109–143, plates 6, figs. 12).—The subjects treated are (1) the Gypsy moth, (2) an insect trap, (3) experiments with Paris green on apple trees, (4) kerosene emulsion for plant lice and red spiders on rose bushes, (5) experiments with Paris green on tent caterpillars, and (6) cranberry insects.

Gypsy moth (pp. 109–116).—An account of the distribution and food habits of the Gypsy moth (*Ocneria dispar*) and detailed descriptions of the insect in its different stages, in continuation of the accounts given in Special Bulletin, November, 1889, and Bulletin No. 7 of the station (see Experiment Station Record, vol. I, p. 225, and vol. II, p. 24). The different stages of the insect and the effect of its ravages on apple orchards and woodlands are illustrated, and a map of the infested region in Massachusetts is given. This region now includes twenty-nine cities and towns in the eastern part of the State.

Numerous parasites were discovered last summer preying upon the eggs and larvæ of the Gypsy moth. The following species, determined by H. Osborn, were found destroying the eggs: *Trombidium bulbipes*, Pack.; *Nothrus* sp. near *ovivorus*, Pack. This species differs from that described by Packard in having but two capitate

appendages on the cephalothorax. According to Osborn, *Phlœothrips* sp. can not be identified positively, though they may be the larvæ and pupa of *P. mali*. They agree well with Riley's brief description of his *Thrips phylloxeræ*, but these are undoubtedly *Phlœothrips*.

The following species were bred from the pupæ of the Gypsy moth: *Theronia melanocephala*, Br.; *Pimpla pedalis*, Cress.; and an undescribed species of *Meraporus*, the last kindly determined for me by L. O. Howard. Besides these, several species of *Diptera* were bred, but they have not yet been determined. *Podisus spinosus*, Dall., black ants, and spiders were found in considerable numbers destroying the larvæ, and no less than ten different species of birds were observed feeding on the caterpillars.

Insect trap (pp. 116–118).—A report on a test of the Monitor Moth and Insect Trap.

These traps are glass jars with a tin arrangement on top, with holes around the side, near the top, through which the insects find their way to the inside of the jar which is partly filled with an odorous liquid strongly attractive to insects. The outside of the glass jar has flowers painted upon it with luminous paint.

Wishing to test the value of the flowers, * * * two unpainted traps were put in the same place and near the others, so that they would have an equal chance with them. The comparison between the painted and unpainted traps showed that the unpainted traps collected quite as many insects as those that were painted, and therefore the painting is a needless expense.

The traps were hung out April 21, and the insects collected from them each day and determined. This was continued until September 15, when the work was closed up. It was not easy to make specific determinations of the insects that had been soaked in the liquid in the traps, but they were determined as accurately as possible with the following results: Beetles, 680 specimens; wasps and bumblebees, 1,024 specimens; butterflies and moths, 17,590 specimens; flies of various kinds, 59,376 specimens. A few plum curculios were taken, but the greater number of the beetles were *Ips fasciatus*, which is a species said to be injurious. There were but a few butterflies and sphinx moths, and only one tent caterpillar moth, which was undoubtedly an accidental capture. * * *

As the majority of the injurious insects taken in these traps fly in the night only, and most of the flies that are beneficial fly in the daytime, I would advise those who use the traps to leave them out only during the night, taking them in or having them closed during the day, so that no insect can get into them. If this is done I think they will prove very useful.

Experiments with Paris green on apple trees (pp. 118, 119).—A brief account of spraying experiments with Paris green (1 pound to 130 gallons of water) on apple trees growing in a greenhouse, one section of which was kept dry and cool, and the other damp and muggy. The foliage in the dry section was injured very little, while that in the damp section was badly burned.

Kerosene emulsion for plant lice and red spiders on rose bushes (pp. 119, 120).—A brief account of a successful experiment on potted rose bushes in a greenhouse.

Experiments with Paris green on tent caterpillars (pp. 121–127).—A detailed account of experiments in which Paris green was used for the repression of the common tent caterpillar (*Clisiocampa americana*) in proportions of 1 pound to from 100 to 1,000 gallons of water. The results are summed up as follows:

(1) The smallest proportions, as 1 pound to 800 or 1,000 gallons, required so long a time to kill the caterpillars that they might wander off or that showers might wash the Paris green from the trees before they would eat enough to kill them; (2) the large or nearly grown caterpillars were quite as readily killed by any of the proportions used in these experiments as those just hatched or in early molts; (3) the proportions of 1 pound of Paris green to 100 gallons of water, or 1 pound to 150 gallons sprayed upon apple trees, in experiments that have been conducted here for 3 years past, have burned the foliage to such an extent as to injure the trees very materially; (4) the most suitable proportions to be used on apple trees in this region, and perhaps throughout the State, are 1 pound of Paris green to 200, 250, or 300 gallons of water.

Cranberry insects (pp. 128–143).—It is estimated that 157,000 barrels of cranberries were raised in Massachusetts in 1891. Great injury is done to the crop by certain insects, chief among which are the vine worm and fruit worm. Replies from cranberry growers to whom a circular of inquiry was sent, are summarized. Replowing or burning the bogs, and the application of tobacco as an insecticide are the means commonly taken for the repression of insects. There is a prejudice against the use of Paris green. The tip worm (*Cecidomyia vaccinii*), vine worm (*Rhopobota vacciniana*), and fruit worm (*Mineola vaccinii*) are described and illustrated.

Experiments at the station indicated that Paris green is an effective remedy for the vine worm. Other experiments, in which different amounts of the insecticides were applied, indicate that the foliage is greatly injured when the solution is stronger than in the proportion of 1 pound of Paris green or London purple to 100 gallons of water, and that a much weaker solution (1 pound to 200 or 300 gallons of water) will kill the vine worm.

The best results in the use of Paris green are obtained by mixing about 2 quarts of glucose, or, if that can not be obtained, molasses with 150 gallons of water and 1 pound of Paris green, and applying with a force pump and nozzle which throws the mixture in the form of the finest mist, and continuing till the plants are thoroughly wet, but stopping before it begins to run off from them. As the Paris green is only in suspension in the water, it should be carefully stirred during all the time the spray is being thrown upon the plants.

Massachusetts Hatch Station, Meteorological Bulletin No. 40, April, 1892 (pp. 4).

A daily and monthly summary of observations for April at the meteorological observatory of the station, in charge of C. D. Warner, B. S.

Michigan Station, Bulletin No. 83, April, 1892 (pp. 26).

INSECTICIDES AND FUNGICIDES, L. R. TAFT, M. S. (figs. 11).—Popular information regarding the preparation and use of insecticides and fungicides for the treatment of insect pests and fungous diseases of plants prevalent in Michigan. Downy and powdery mildews of the grape, apple scab, pear blight, black knot of the plum and cherry, brown rot of stone fruits, shot hole fungus (*Septoria pruni*), plum pockets (*Taphrina pruni*), and wheat rust (*Puccinia graminis*) are described and illustrated.

Michigan Station, Bulletin No 84, April, 1892 (pp. 6).

ROOTS VS. SILAGE FOR FATTENING LAMBS, P. M. HARWOOD, B. S., AND F. B. MUMFORD, B. S.—To test the relative value of sugar beets and silage for fattening lambs, 16 grade Shropshire lambs were divided into two lots and fed during two separate periods. Lot 1 received beets and clover hay *ad libitum* and lot 2 silage and hay *ad libitum* during 6 weeks (first period). In a transition period of 1 week the lots were alternated, and for 6 weeks following (second period) lot 1 received silage and hay, and lot 2 beets and hay. During the whole trial the lambs each received 1 pound per day of a grain mixture consisting of two parts of oats and one of bran. The lambs were purchased about October 15, at 4.5 cents per pound. The trial commenced December 9. The amounts of food consumed, gains in live weight, and the financial results, based on oats at 32 cents and bran at 15 cents per bushel, hay at $7.50, and silage and roots each at $2.50 per ton, are tabulated. The average gain of the lambs while on roots was 3 pounds per week and while on silage 2.5 pounds per week. "This experiment indicates that (1) roots are superior to silage for fattening lambs; (2) either roots or silage may enter largely into the fattening ration, and, allowing a reasonable valuation on each, may be fed at a profit; (3) lambs may be successfully fattened without the use of a heavy grain ration; (4) fattening lambs under existing conditions in Michigan is a profitable enterprise and is worthy of the most careful thought and study of all engaged in mixed farming."

Michigan Station, Bulletin No. 85, April, 1892 (pp. 21).

FIELD EXPERIMENTS WITH POTATOES, L. R. TAFT, M. S.—These were in continuation of the experiments recorded in Bulletins Nos. 57 and 70 of the station (see Experiment Station Record, vol. II, pp. 58 and 584) and included a test of varieties and experiments in planting different kinds and amounts of seed, in planting at different distances, and with fertilizers. In 1891 drouth caused the crop to ripen prematurely, and reduced the yield, especially of the late varieties.

Test of varieties.—Tabulated data are given for 140 varieties and descriptive notes on 49 varieties grown at the station for the first time in 1891.

As an extra early sort Howe Premium has again shown itself one of the best. Although only fairly productive, it is of excellent quality, and for home use well worth planting.

Of the new sorts we can not make exact comparisons as to season, on account of their premature ripening, but McFadden Earliest and Queen of Paris showed little signs of blight, were ripe on August 8, and produced 237.5 bushels and 336.8 bushels, respectively. They seemed to be nearly as early as Premium, and were much more productive.

[The yields in bushels per acre of some of the more promising varieties were as follows:] New Queen 288, Tonhocks 263.7, Signal 261.2, Early Minnesota 240, Early White Beauty of Hebron 220, Beauty of Hebron 206, Early Oxford 213. Following within

a week as medium-early sorts were Early Pearl 277.8, Thorburn 233, Fort Collins No. 83 240, Early Rose 228.1, Putnam's New Rose 194, Early Puritan 206, Freeman 213, and Faust 1889 203. The best sorts that would be classed as medium-late were West No. 3 261.7 (rather coarse), P. and W. Victory 231, Lazell Seedling 228.7, Perfection 213.4, and Supplanter 206.2. The best late sorts were Empire State 273, Halo of Dakota 261.2, Ideal 258, White Elephant 209.7, Crown Jewel 208.3, and Rural Blush 206.4.

With the exception of West No. 3, every one of these varieties was on the selected list of varieties tested at the station in 1890 and a number of them were also highly commended in 1888 and 1889.

Seed ends for planting.—The results of an experiment in 1891 with the stem end, middle, and seed end of potatoes for seed are tabulated and compared with those of the 2 previous years. The average yield in bushels per acre for the 3 years have been as follows: Stem end 173, middle 143, seed end 183.

Whole tubers vs. cuttings for seed.—The results of an experiment in 1891 with 2 varieties are tabulated and compared with those for the 2 previous years. The average yields in bushels per acre for 3 years have been as follows:

	Whole tubers.	Halves.	Quarters.	Eighths.	Single eyes.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Marketable tubers	177.5	169.4	135.3	121.3	99.8
Average amount of seed	58.9	28.6	14.7	7.5	4.3
Net gain per acre	118.6	140.8	120.6	113.8	95.5

Planting at different distances.—Tabulated data are given for an experiment in which single eyes, quarters, and halves were planted at intervals of from 1 to 2.5 feet in the row. The results in 1891 are compared with those in 1890. The largest net yield was obtained from halves, using 13.2 bushels of seed per acre, planted at intervals of 2 feet.

Large vs. small potatoes for seed.—Tabulated data are given for an experiment in which halves and whole potatoes weighing from 1 to 4 ounces were planted. The results in 1891 are compared with those in 1890.

As grown in 1890, halves of any weight gave a larger market yield than whole tubers of twice the size, and the largest net yield was found from halves of 2-ounce potatoes or at the rate of 13.7 bushels per acre.

This year the results are more irregular, and owing to the unfavorable season and it may be to some irregularity of the soil that was not apparent to the eye, it is difficult to draw definite conclusions from them. The largest net yield for two years has been secured from halves of 1-ounce potatoes planted at the rate of 6.8 bushels per acre, and the next best yield from halves of 2-ounce potatoes at the rate of 13.8 bushels per acre.

Fertilizer tests.—These were on 27 plats, each containing 4 square rods.

The fertilizers used were stable manure under and over the seed and as a mulch between the rows, wood ashes, nitrate of soda, sulphate of ammonia, dissolved

boneblack, ground bone, muriate of potash, and sulphate of potash, each alone and in various combinations, besides Odorless (iron) Phosphate, bone and potash, and Homestead superphosphate.

The manure was applied at the rate of 20 loads (10 cords) per acre, the ashes at the rate of 40 bushels, sulphate of ammonia at the rate of 160 pounds, nitrate of soda 240 pounds, muriate and sulphate of potash 240 pounds, and ground bone and dissolved boneblack 400 pounds. The highest application to any plat consisted of a mixture of 240 pounds of muriate of potash, 240 pounds of nitrate of soda, and 400 pounds of ground bone, at an expense of $16 to $18 per acre. The least expensive fertilizer was 240 pounds of sulphate of potash, at a cost of $3.50.

Four varieties were used in the test in each plat, but by an error in selecting the seed only 2 of these were the same throughout, and exact comparisons can not be made except of the yields of these varieties.

The results as tabulated indicate that the highest yield was attained when stable manure was used as a mulch between the rows. Manure over the seed increased the yield more than manure under the seed, but this result was reversed in the case of the other fertilizers. The chemical fertilizers were profitably used. Nitrogen perhaps had the least effect, but potash and ground bone alone or in combination materially increased the yield. "Of the commercial mixtures the Odorless Phosphate made the best showing. * * * The Homestead superphosphate was also a profitable one to apply."

Mississippi Station, Fourth Annual Report, 1891 (pp. 37).

FINANCIAL REPORT (p. 4).—This is for the fiscal year ending June 30, 1891.

REPORT OF DIRECTOR, S. M. TRACY, M. S. (pp. 5-7).—Brief statements regarding the buildings, equipment, work, and publications of the station.

FIELD EXPERIMENTS WITH CORN (pp. 8-10).—Fertilizer tests are reported in continuation of those recorded in the Annual Report of the station for 1890 (see Experiment Station Record, vol. II, p. 657). Stable manure, acid phosphate, cotton-hull ashes, cotton seed, cotton-seed meal, kainit, and Furman's formula (stable manure, cotton seed, acid phosphate, and kainit) were the fertilizers used. The greatest and most profitable yield was obtained with Furman's compost applied in the drill at the rate of 1,000 pounds per acre. The results in 1891 agreed with those of previous years in indicating that a fertilizer containing an abundance of vegetable matter is required on exhausted hill lands of yellow and red clay like those at the station.

FIELD EXPERIMENTS WITH COTTON (pp. 10-22).—These included experiments with fertilizers and tests of varieties.

Cotton, fertilizer experiments.—Accounts are given of experiments with cotton, similar to those with corn referred to above, on different kinds of soil at the station and substations, in continuation of those reported in the Annual Report of the station for 1890 (see Experiment Station Record, vol. II, p. 656).

[In general it has been found that on the yellow loam of the hill regions of the State,] while good results have always been obtained by the use of a mixture of potash and phosphoric acid salts, results have been still better when the soil has received a fair supply of vegetable matter in addition. Whether this vegetable matter is derived from composting the commercial salts with cotton-seed meal, cotton seed, or stable manure seems to make but little difference, though if manure is used much more will be required than of the meal or seed. The results of the work of the past year both at the home station and at the Holly Springs branch have served to strengthen these conclusions.

The yellow loam or "post oak" region of the State has in nearly all places a large excess of lime. Such soils are usually wanting in vegetable matter, which must be supplied either by growing some crop for plowing under, or by some form of fertilizer. The value of cowpeas as a green manure is too well known to need comment here, but there are other crops which are often even more profitable for this purpose. Melilotus grows well on all lime soils, and where the subsoil is close and heavy it is undoubtedly the best crop which can be grown as a green manure. * * * For very thin red or yellow soils Japan clover is an excellent fertilizer and will grow on a soil which is too poor to produce a good crop of peas and so destitute of lime as to be unfit for melilotus, but on soils suited to their growth either red clover, melilotus, or cowpeas give better results. * * *

For the pine-woods region, where the soils are almost uniformly deficient in lime, both phosphoric acid and potash are needed in a fertilizer, though the phosphoric acid seems the more important of the two. Such soils are usually deficient in vegetable matter also, which must be supplied in some form. Peas grow well on these soils and is probably the best green crop which can be used, and either cotton seed or cotton-seed meal are also used to advantage.

Cotton, test of varieties.—Tabulated data are given for 46 varieties grown in 1891, and the results are compared with those obtained in previous years.

Flax culture (pp. 22–24).—Seed of Medium and Bold Calcutta flax was sown in January and March. "From both the winter and the spring sowings the Bold Calcutta plants were a trifle the larger, but otherwise there was no marked difference between them, although there was a marked difference in the seed, that from the Bold Calcutta being much larger and plumper." The work in this line will be continued.

Wheat, test of varieties (pp. 24, 25).—A brief account of a test of 12 English and 2 French varieties. The English varieties were late in ripening and were very badly injured by rust. The French varieties yielded 17 and 27 bushels per acre.

Grasses (pp. 25, 26).—A general statement regarding the tests of species of grasses being carried on in the Southern States in coöperation with this Department. Details will be given in Bulletin No. 20 of the station and in the Report of the Secretary of Agriculture for 1891.

Feeding experiments (pp. 26–28).—Thirty grade cows divided into 6 lots of 5 each (four Jerseys and one Holstein), were fed 5 weeks, beginning January 13, to test the relative value of different foods for the production of milk and butter. The hay used was analyzed with the following results:

Analyses of hay used in feeding experiments.

	Moisture.	Crude fiber.	Crude protein.	Crude fat.	Carbohydrates.	Ash.
In original material:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Old Bermuda hay	12.69	25.20	6.56	2.18	45.45	7.92
New Bermuda hay	14.62	25.85	6.87	1.66	44.40	6.96
Timothy hay	11.79	29.76	5.00	3.43	42.88	7.15
In water-free substance:						
Old Bermuda hay		28.86	7.52	2.49	52.06	9.07
New Bermuda hay		30.17	8.01	1.93	51.78	8.11
Timothy hay		33.74	5.67	3.87	48.61	8.11

The results of the experiment are summarized as follows:

Lot.	Daily ration per animal.	Cost of food.	Milk.			Butter.		Gain in live weight.
			Yield.	Cost per gallon.	Butter fat.	Yield.	Cost per pound.	
			Gals.	*Cents.*	*Per ct.*	*Pounds.*	*Cents.*	*Pounds.*
1	9.2 pounds Bermuda hay, 9.5 pounds raw cotton seed	$12.16	154.99	7.7	5.62	69.70	17.4	100
2	10.5 pounds Bermuda hay, 10.6 pounds roasted cotton seed	14.55	171.79	8.5	5.55	76.30	19.1	205
3	8.5 pounds Bermuda hay, 10.4 pounds steamed cotton seed	13.07	136.17	8.8	5.64	61.48	19.6	214
4	9.9 pounds Bermuda hay, 9.9 pounds corn meal	26.42	206.32	12.8	3.86	63.72	41.4	*34
5	8.5 pounds timothy hay, 9.5 pounds raw cotton seed	16.40	127.55	12.8	5.43	55.46	29.5	197
6	10.9 pounds Bermuda hay, 9.5 pounds raw cotton seed	22.34	181.68	12.3	5.38	78.37	28.5	90

* Loss.

As far as the lines of work were parallel the results of this experiment agree with those of a previous experiment reported in Bulletin No. 13 of the station (see Experiment Station Record, vol. II, p. 362).

Bermuda and timothy hay were each fed to 3 working mules for 2 months with substantially the same results.

COMPARISON OF MILK TESTS (pp. 28, 29).—Analyses by the gravimetric, Babcock, Beimling, and Patrick methods are tabulated. "All of the methods give fairly accurate results, but in the majority of the cases the methods of Beimling and Patrick tallied more nearly with the gravimetric, while the Babcock fell slightly low, but not enough so to injure the value or accuracy of the method for practical work."

HORTICULTURAL WORK (pp. 29–32).—Brief accounts of tests of varieties of strawberries and grapes and of experiments with potatoes and orchard fruits.

ENTOMOLOGICAL WORK (pp. 32–36).—Besides reference to the accounts of work published in Bulletins Nos. 14 and 17 of the station (see Experiment Station Record, vol. II, p. 659, and vol. III, p. 702), notes are given on the bollworm (*Heliothis armigera*), *Termes flavipes*, horn fly (*Hæmatobia serrata*), chinch bug (*Blissus leucopterus*), lady beetle (*Hippodamia convergens*), and pear tree borer (*Sesia pyri*). Four analyses of Paris green are given.

METEOROLOGICAL SUMMARY (p. 37).—Tabulated data for each month of 1891. The averages for the year were as follows: *Pressure* (inches).—Average 29.7. *Air temperature* (degrees F.).—Maximum 97; minimum 19; average 63.6. *Humidity.*—Relative humidity 75. *Precipitation.*—Total (inches) 61.17; number of days on which rain fell 84. *Sunshine* (hours).—Total 2,482. *Wind.*—Total movement (miles) 69,191.

Missouri Station, Bulletin No. 17, January, 1892 (pp. 28).

SUGAR BEETS IN MISSOURI, C. P. FOX.—This includes general information regarding the culture of sugar beets, and reports on experiments at the station and elsewhere in Missouri.

Five varieties grown at the station in 1890 averaged 14 per cent of sucrose in the juice, but 4 of these varieties in 1891 averaged only 12.64 per cent. The difference in sugar content is attributed to differences in climatic conditions. The results of analyses of 57 samples from 20 counties of the State, as tabulated, show percentages of sucrose ranging from 4.59 to 18.85 and averaging 9.81. The temperature is higher and the rainfall greater in Missouri than in the beet-growing regions of Europe and the soil is largely unfit for beet culture. The outlook for the introduction of this industry into Missouri is not promising, but the experiments will be repeated.

New Hampshire Station, Bulletin No. 15, December, 1891 (pp. 7).

PATENT CATTLE FOODS, G. H. WHITCHER, B. S., AND F. W. MORSE, B. S.—This includes analyses of Pratt's Food, Weston's Condition Powders, and Climax Food, which have been extensively used in the State. The samples analyzed were purchased in the open market. The Pratt's Food sold at 75 cents per package of 12 pounds or $6 per 100 pounds. "The food appears to be wheat middlings, to which has been added some fenugreek." The condition powders sold at 50 cents per package of 3 pounds. "In appearance it resembles a mixture of corn meal and cotton-seed meal, and it had a saline taste and strong odor of fenugreek." It was found to contain chlorine equivalent to 4.7 per cent of common salt, about the same percentage of fat as corn meal, but considerably more protein and ash than the latter. The Climax Food sold at $1 for 12½ pounds or $8 per 100 pounds.

In appearance it resembled a mixture of fine wheat middlings and wheat screenings, together with a small quantity of caraway or fennel seeds and small bits of a substance like butternut or elm bark. It had, like the other samples, a strong saline taste and odor of fenugreek. * * *

The comparison shows that the Climax has only its extremely high percentage of ash to warrant a claim to being a concentrated food. The Climax also contained 5.59 per cent of sulphur, and in the water solution were found chlorine 5.92, sulphuric anhydride 2.53, and sodium oxide 8.54 per cent, together with traces of potassium and magnesium and a large amount (qualitatively) of nitric acid.

New Jersey Stations, Bulletin No. 86, April 4, 1892 (pp. 20).

SPRAYING FOR INSECT AND FUNGOUS PESTS OF THE ORCHARD AND VINEYARD, J. B. SMITH AND B. D. HALSTED, D. SC.—Popular information regarding the treatment of the codling moth, plum curculio, plant lice, peach borer, apple borers, rose chafer, apple scab, apple rust (*Gymnosporangium macropus*), apple mildew (*Podosphæra oxycanthæ*), apple bitter rot (*Glœosporium fructigenum*), pear and quince leaf blight, peach leaf curl (*Exoascus* (*Taphrina*) *deformans*), peach fruit rot (*Monilia fructigena*), black rot of plums, plum pockets (*Exoascus* (*Taphrina*) *pruni*), cherry shot-hole blight (*Septoria cerasina*), grape mildews, and black rot of grapes.

New Jersey Stations, Bulletin No. 87, April 13, 1892 (pp. 28).

ANALYSES OF COMMERCIAL FEEDS, E. B. VOORHEES, M. A.—Analyses with reference to food and fertilizing ingredients are given of 85 samples of feeding stuffs collected by station officials early in November from large dealers in ten local centers of the State. These include corn meal, cracked corn, wheat bran, wheat middlings, corn and oats, linseed meal, cotton-seed meal, malt sprouts, rye bran, dried brewers' grains, hominy meal, ground oats, dark feeding flour, ship stuff, wheat shorts, buckwheat bran, buckwheat middlings, rye middlings, gluten meal, "grano" gluten, glucose meal, rye feed, oat feed, oat hulls, corn bran, and mixtures of hominy, oats, and rye, hominy meal and oats, and corn, oats, and rye. Grano gluten is described as a cooked and dried distillery waste, consisting principally of the nitrogenous part of the grains used. Its composition, together with that of oat hulls, was as follows:

Food ingredients in grano gluten and oat hulls.

	Water.	In dry matter.					
		Crude ash.	Crude cellulose.	Crude fat.	Crude protein.	Albuminoid protein.	Nitrogen-free extract.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Grano gluten	5.82	3.01	12.70	15.78	33.05	32.05	35.46
Oat hulls	7.28	7.22	32.00	1.05	3.51	3.37	56.22

Fertilizing ingredients in grano gluten and oat hulls.

	Water.	Nitrogen.	Phosphoric acid.	Potassium oxide.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Grano gluten	5.82	4.98	0.51	0.15
Oat hulls	7.28	0.52	0.24	0.52

"The former [grano gluten] promises to be a valuable addition to our list, while the latter is poor, containing a high percentage of crude fiber largely indigestible. Its sale is not likely, however, to assume great proportions. Oat hulls are frequently used by millers to grind with corn in the place of oats. * * * No evidence of injurious or willful adulteration was discovered."

The average composition of each kind of feeding stuff analyzed is compared with the average figures given in Jenkins and Winton's Compilation of Analyses of American Feeding Stuffs (see Experiment Station Record, vol. II, p. 701). The article also includes popular discussions on the following subjects: Cost per pound of the food ingredients in the different feeding stuffs analyzed, illustrated by tables; economical methods of using feeds, with formulas for rations for young stock, fattening animals, milch cows, and work horses; and the relative value of the fertilizing constituents contained in the different feeds.

New Jersey Stations, Special Bulletin O, April 6, 1892 (pp. 26).

EXPERIMENTS WITH NITRATE OF SODA ON TOMATOES, E. B. VOORHEES, M. A.—Field experiments with nitrate of soda on tomatoes, made in 1889–90 and reported in Bulletins Nos. 63 and 79 of the station (see Experiment Station Record, vol. I, p. 261, and vol. III, p. 30), indicated that this material, under proper conditions of use, is a valuable fertilizer for tomatoes. To further test this matter experiments were made in 1891 on two different farms, one (Mr. Gill's) having a sandy loam soil in a good state of fertility, and the other (Mr. Housel's) a light clay loam, "apparently deficient in all the essential plant food elements." Each experiment included 12 twentieth-acre plats, 2 of which remained unmanured. The fertilizers were applied as follows: On 8 plats nitrate of soda 160 and 320 pounds per acre, alone and in combination with boneblack 320 pounds and muriate of potash 160 pounds per acre, the nitrate being used all at one time or in two separate portions; on 1 plat boneblack and muriate of potash 320 and 160 pounds per acre, respectively; and on 1 plat barnyard manure. Early varieties of tomatoes were used in both cases, the plants being started under glass from seed sown in February. In Mr. Gill's experiment the plants were set and the fertilizers applied on May 4, and in Mr. Housel's experiment, May 11. The plants were checked 4.5 by 4.5 feet apart. The second application of nitrate of soda was made in Mr. Gill's experiment June 2, and in Mr. Housel's experiment June 12. The results of both trials are fully tabulated, showing the yield and selling price of tomatoes at different pickings, the relation of the yield and value of early tomatoes to the total yield and total value of the crop, the net value of the crop per acre on the different plats, etc. The results of the two experiments are considered separately.

Mr. Gill's experiment "was not altogether satisfactory, either in regard to early yield or prices, the cold weather in May seriously retarding growth and the prices in July being much lower than usual."

The total yield of early tomatoes was very largely increased on all plats treated with nitrate; minerals alone on plat 6 were also decidedly beneficial, though their use in connection with nitrate of soda seemed to reduce rather than increase the total yield. Barnyard manure on plat 11 did not materially influence the yield, and in this respect the results agree with those secured in the experiment of 1889. The average yield of early tomatoes on the [unfertilized] plats agreed closely. Using this yield as a basis of comparison, it is shown that nitrate of soda decidedly influenced maturity, and that the modifying factors were mainly quantity applied and method of use, *i. e.* whether applied alone or in connection with the mineral elements—phosphoric acid and potash.

The results do not seem to have been in any way influenced by fractional applications of the nitrate of soda. * * *

The final and vital test of increased maturity is, however, based upon financial considerations, for the yield up to a certain date may be increased in proper proportion and still not be proportionately increased in value. * * *

By the use of nitrate of soda alone [160 pounds per acre] the yield was increased 213.2 pounds or 84.5 per cent, and the value $3.98 or 74.7 per cent; with nitrate of soda [160 pounds] in connection with minerals, the yield was increased 167.5 pounds or 66.4 per cent, and the value $3.01 or 56.5 per cent; with nitrate of soda alone [320 pounds] the yield was increased 126.1 pounds or 50 per cent, and the value $1.89 or 35.5 per cent; with nitrate of soda [320 pounds] in connection with minerals the yield was increased but 60.3 pounds or 23.9 per cent, and the value 50 cents or 9.4 per cent; minerals alone increased the yield 134.2 pounds or 53.2 per cent, and the value $3.06 or 57.4 per cent. In other words, the money value of early tomatoes increased in proportion to the increased yield only when small quantities of nitrate of soda were used either alone or in connection with minerals, while with large quantities the money value of early tomatoes was relatively less than the increased yield. From the standpoint of money value, maturity was proportionately increased by small quantities of nitrate of soda, however used, and proportionately decreased when large quantities were used, while the actual money value of the early tomatoes was greater in all the groups with nitrate than upon the unfertilized land. * * *

The results this year indicate that nitrate of soda did not increase the yield at the expense of money value of early tomatoes under any of the conditions of the experiment, and that the best results were secured from the use of small quantities of nitrate of soda alone. This, therefore, further emphasizes the conclusion that, properly used, nitrate of soda is a profitable fertilizer for tomatoes.

In Mr. Housel's experiment the soil selected was poor, and while not heavy, was compact in texture, with a tendency to puddle after working, and proved unfavorable for the growth of early tomatoes. Practically the first picking was on July 22 and the fruit ripened very slowly up to August 18.

While the yields on plats treated with nitrate of soda alone are somewhat larger than where nothing was used, the increase is too small to be taken into consideration. Using the yield on plat 1 as representing the unmanured land, minerals increased the yield more than 150 per cent, while nitrate of soda and minerals together increased it on an average of 179 per cent.

The yield and value of early tomatoes on the nitrated plats were also proportionately greater, *i. e.* there was a greater increased maturity than on the plats treated with minerals alone. * * *

Nitrate of soda alone on the average was not profitable, merely paying for the nitrate used; minerals increased the net value per acre by $83.06; nitrate with

minerals, by $108.04; barnyard manure was less effective than minerals alone, increasing the net value but $26.69.

As in the other experiments, the greatest net value was secured from the smaller quantity of nitrate of soda, and in both cases the second application proved of value. * * *

The average results secured under the varied conditions of soil and season, included in the three years of experiment, seem to warrant the practical conclusion that under the conditions considered favorable for the growth of tomatoes, that is, good cultivation and previous liberal fertilization, the application of 160 pounds per acre of nitrate of soda alone will be uniformly more profitable for early tomatoes than combinations of minerals, barnyard manure, or a complete fertilizer.

New Jersey Stations, Special Bulletin P, April 9, 1892 (pp. 24).

FIELD EXPERIMENTS WITH FERTILIZERS ON POTATOES, E. B. VOORHEES, M. A. (pp. 3-16).—These were in continuation of experiments in 1890, reported in Bulletin No. 80 of the station (see Experiment Station Record, vol. III, p. 32), and were carried out on three farms within the State, which will be designated by number. The main objects were to compare (1) barnyard manure with commercial fertilizers, (2) mixed minerals with complete fertilizers, (3) muriate and sulphate of potash with kainit, and (4) nitrate of soda with dried blood.

The land used for experiment No. 1 was of medium fertility, well adapted to potatoes, and had received no manure since 1885; that for No. 2 was of fair natural fertility and had not been manured since 1886. The soil used for No. 3 "was uniform in character, and while of good natural fertility had suffered neglect. * * * Manures had never been used in large quantities."

Each experiment included 14 twentieth-acre plats. Three of these remained unmanured; 1 received 20 tons of barnyard manure per acre, and another 10 tons of manure with 100 pounds nitrate of soda, 160 pounds boneblack, and 80 pounds sulphate of potash. On the others combinations of 320 pounds boneblack, with 160 pounds muriate of potash, 160 pounds sulphate of potash, and 640 pounds of kainit were used without nitrogenous fertilizers, and each of these combinations was applied with 200 pounds nitrate of soda, and with 280 pounds dried blood, furnishing like amounts of nitrogen per acre. This arrangement afforded opportunity for comparing the effects of the three potash manures with each other in two series of plats, with and without nitrogen, and of comparing the nitrogenous fertilizers with each other and with mixed minerals. Early Rose potatoes were raised in the first two experiments and Burbank in the third.

"The season in Gloucester County [where experiments Nos. 1 and 2 were located] was but fairly favorable throughout; in Middlesex County [No. 3] the amount of rain was below the average in May and June and the weather rather cool, but the vines made a continuous and rapid growth."

Detailed statements of the yield of large and small potatoes for each plat, the net value of the marketable potatoes, and the net gain or loss are tabulated for each experiment.

The highest yields from fertilized plats were practically identical [in experiments Nos. 1 and 2] and were secured in both cases from the chemical manures; [in experiment No. 3] the barnyard manure gave the highest yield, though this yield was lower by 20 bushels per acre than in the case of the others. In other words, the fertilizers increased the yield 386 pounds per plat, or 207 per cent in No. 1, 423 pounds or 236 per cent in No. 2, while in No. 3 the increase was but 258 pounds or 106 per cent. This would seem to indicate what is frequently insisted upon, that, other things being equal, fertilizers act more favorably and uniformly on land in which the previous culture and treatment have been good. * * *

The number of small potatoes was also decidedly reduced by the use of manures, though it was impossible to draw a strict line between merchantable and unmerchantable tubers. * * *

In experiment No. 1 the yields from the sulphate of potash were 14.8 bushels or 10 per cent greater than from the muriate; in experiment No. 2 the muriate gave 20.5 bushels or 13 per cent more than the sulphate; in experiment No. 3 the yields from the two were practically identical; the yield from the use of kainit was in all cases much lower than from the other forms of potash used. Averaging the three experiments, the yields from the muriate and sulphate were practically identical, while that from kainit was 19 per cent lower than the average of the yields from the muriate and sulphate.

These results are in general in accord with those secured in 1890 and confirm the statements then made, viz. that in the use of muriate or sulphate the main consideration is the cost, the cheaper muriate being quite as effective as the sulphate, and that the direct application of large quantities of kainit is not advisable for potatoes, for while the actual potash may be quite as effective in increasing the yield as in the other forms, it has a tendency to injure the plants and thus prevent a full stand. * * *

In all the experiments there was an increase from the use of nitrogen, and in experiments Nos. 2 and 3 it proved necessary in order to secure a profit. * * *

In two cases out of three there was a greater gain from the use of dried blood. With the exception of experiment No. 1, where the nitrate seems to have been without appreciable effect, the increase in yield from the two forms is very uniform. The average yield of all the experiments is increased 29.5 per cent by the use of nitrate of soda and 35.9 per cent by the use of dried blood. The results of these experiments therefore simply indicate that where nitrogen is found useful, such readily available forms as dried blood may be quite as effective as the more soluble nitrate.

Allowing 40 cents per bushel for merchantable potatoes and \$30 per acre for the cost of growing potatoes, exclusive of manures, "the profits per acre secured from the different methods of manuring appear as follows:"

	Expt. 1.	Expt. 2.	Expt. 3.
Barnyard manure alone	\$4.92	—\$2.40	\$6.52
Barnyard manure and chemical manures	13.91	12.23	0.11
Chemical manures alone	15.78	19.64	7.44

A profit is secured in all cases except from barnyard manure in experiment No. 2.

The chief conclusions to be drawn from these experiments are that (1) on the whole the use of manures was profitable; (2) the best results were secured from the use of chemical manures; (3) kainit was less effective than either muriate or sulphate of potash, and the sulphate did not produce larger yields than the muriate; (4) nitrogen was a valuable ingredient of potato manures.

As in 1890, samples of the potatoes from the differently manured plats were taken for analysis. The indications from the analyses in 1890 were that manuring materially affected the composition of the potato, decreasing the starch, and that in this respect the effect of sulphate of potash was less than that of either muriate of potash or kainit.

The analyses in 1891 show that while on the average there was less dry matter in samples from plats treated with manures, those from plats which received sulphate of potash contained more dry matter than the samples from the unfertilized plats, while with one exception those from muriate of potash and kainit contained less. The samples from the fertilized plats also contained less nitrogen and more ash than those from the untreated plats; as a rule the ash was the highest and the nitrogen the lowest on samples from the kainit plats. With one exception, the highest nitrogen in samples from fertilized plats was secured from those treated with sulphate of potash.

In respect to nitrogen as albuminoids, it is shown that while on the average nearly 50 per cent was in this form and the greatest amount was contained in the potatoes from the unfertilized plats, it was proportionately greater upon the fertilized plats.

Samples from the different plats in each experiment were also cooked under uniform conditions, and, with the exception of those grown by Mr. Gardiner, the results were decidedly in favor of the sulphate of potash. These results simply confirm those secured in 1890, in showing that while on the whole manures have a tendency to decrease the dry matter of the potato, in using those which contain potash in the form of sulphate the amount of dry matter of the potato is not materially different from that secured when no manures are used.

Field experiments with fertilizers on sweet potatoes, E. B. Voorhees, M. A. (pp. 17–24).—It is explained that the common practice in growing sweet potatoes in New Jersey is to scatter broadcast from 8 to 10 tons per acre of manure, chiefly horse manure, and to apply an equal amount in the hill or row at the time of setting the plants. The object of the experiment was to ascertain whether satisfactory crops can be raised without barnyard manure, and to compare the effects of commercial fertilizers, barnyard manure, and a mixture of the two. The general plan was identical with that followed in the experiments with white potatoes reported above, except that the plats were 5 by 436 feet in one case and 10 by 218 feet in another. The experiments were made on two farms. In experiment No. 1 the plants were set May 14 in rows 2.5 feet apart, being 18 inches apart in the row. In experiment No. 2 the plants were set 2.5 feet apart each way, May 22–29, but many died and had to be replaced in June. The yields and the financial results are tabulated for both trials. In the case of experiment No. 2 "the yields on the different plats were too uneven to warrant any conclusions."

In both cases it is plainly shown that sweet potatoes may be grown with chemical manures alone. Since the second-size potatoes are saleable the influence of fertilizers upon size of roots is worthy of notice. The average total yield of unfertilized land in experiment No. 1 was 215.7 bushels, of which 56.3 bushels or 26 per cent were small potatoes; the average total yield of all fertilized plats was 286.4 bushels, of which 52.1 bushels or 18 per cent were small. In experiment No. 2 the average yield of the unfertilized land was 20 bushels, of which 5.2 bushels or 26 per cent were small; the

average yield of the fertilized plats was 83.1 bushels, of which 16.6 bushels or 20 per cent were small. In other words, the use of manures caused a proportionate decrease in small roots.

[In experiment No. 1] those grown with chemical manures alone were bright and smooth of skin, while at least one third of those grown with barnyard manure were rough and partially covered with scurf. * * * It was apparent from the time of setting the plants that the kainit was injurious, not perhaps because of the form of potash, but because of the very large quantities of salt necessarily applied in order to secure the same amount of actual potash. * * * While the direct application of both muriate and sulphate resulted in a decided increase in profit, the kainit caused a material loss. It should not be argued from this, however, that kainit is not a good source of potash, but rather that its direct application in large quantities may be injurious, as was also noted in the experiments with white potatoes. An earlier application of the sulphate may also have been more effective than when applied immediately before setting the plants. * * * The form of nitrogen most favorable was the dried blood, the gain being $9.68, or 31 per cent greater than from the nitrate of soda.

[The conclusions reached were] that (1) the yield of sweet potatoes may be very profitably increased by the use of chemical manures alone; (2) a combination of chemical and barnyard manures is especially useful; (3) nitrogen is a valuable ingredient in the fertilizers used for this crop; (4) organic forms of nitrogen, as dried blood, are more desirable than nitrate of soda; (5) muriate of potash is more useful than the other commercial forms.

Analyses were made of samples of the sweet potatoes from the differently fertilized plats. The results are not tabulated in the bulletin, but will appear in the Annual Report of the stations. "The chief effect of manures upon composition was to decrease the dry matter, the loss averaging about 5 per cent, and falling mainly upon the carbohydrates. About 90 per cent of the crude protein in sweet potatoes exists in the form of albuminoids. The slight increase in crude protein from the use of manures was followed in all cases by a proportionate increase in the albuminoids."

New Jersey Stations, Special Bulletin Q, April 21, 1892 (pp. 12).

SOME FUNGOUS DISEASES OF CELERY, B. D. HALSTED, D. SC. (figs. 14).—Accounts of celery blight, leaf spot, leaf blight, rust, and a bacterial disease.

Celery blight.—Brief statements regarding the conditions favorable to the development of celery blight (*Cercospora apii*), and an account of a successful field experiment in spraying celery plants once a week (from August 6 to the close of the season) with ammoniacal carbonate of copper for the repression of this disease.

Celery leaf spot.—This disease was observed in a field of celery in New Jersey in 1891, and is due to a species of fungus which the author proposes to call *Phyllosticta apii*. Portions of a leaf affected with the disease and the spores of the fungus are illustrated.

The *Phyllosticta* begins as a dull brown patch, never becoming of the light ashy color so characteristic of the *Cercospora* in one of its stages. In the *Phyllosticta* the leaflet may be attacked only in one spot, which continues to enlarge until the

whole becomes brown and lifeless, followed by a torn condition. Two or three of these large, dead, shredded places may be all that the leaf contains, while the balance is healthy and deep green. * * * A careful study was made of the *Phyllosticta* and *Cercospora* by means of cultures. Each reproduced its own kind in every instance.

It was particularly easy to grow the *Phyllosticta* upon sterilized petioles in test tubes, and transfers were repeatedly made from pure cultures of this fungus without a trace of *Cercospora* appearing. The pycnidia would form and mature in great abundance within 5 days, and even upon the surface of the liquid, at the bottom of the tube, as well as the petiole itself. * * *

This is a rapidly growing fungus, is particularly fond of moisture, and flourishes in the shade, being found usually upon the younger or lower leaves.

While experiments have not been made upon this leaf spot fungus, it is probably true that the same remedy as that for the ordinary leaf blight (*Cercospora*) applied in the same manner would prove effective. It will be important to begin early with the spraying.

Celery leaf blight.—A second form of leaf blight (*Septoria petroselini*, var. *apii*) was observed in 1891 in Delaware by Professor Chester and in New Jersey by the author. Portions of diseased leaves and the spores of the fungus are illustrated.

The blight now under consideration often causes the whole leaf to become brown, with small black dots scattered over the surface. A plant at all affected is quite apt to have the whole foliage diseased. * * *

The only other mention of a *Septoria* upon celery that the writer has thus far found is by Briosi and Cavara (*Funghi Parisitti Fasceola*, 6, 144), who figure and present a specimen of the species upon celery, namely, *Septoria petroselini*, Desm., var. *apii*, B. & C., collected at Pavia, Italy, in 1890. The American specimens, while not agreeing closely in the spore measurements, may be considered as belonging to the same variety.

Celery rust.—While the genuine celery rust (*Puccinia bullata*) has not been reported in this country, it is prevalent in Europe and may be expected here at any time. A brief illustrated account of this fungus is given in this article.

A bacterial disease of celery.—This was observed in celery fields near Greenville and Bayonne, New Jersey, especially on the Golden Plume variety. The bacteria and a portion of an affected leaf are illustrated. The bacteria were observed under the microscope, isolated, and grown on celery leaves.

The affected leaves were badly blotched with brown, the diseased spots having a watery appearance. * * * The germs when introduced into the core of a plant cause this tender portion to decay with greater rapidity than when placed in leaf tissue. * * * It was observed that the bacteria increased most rapidly when the celery is kept constantly moist, but not submerged. * * * That this disease is serious may be judged from the fact that a large grower has lost nearly his whole last crop, the heart of each plant melting away to a worthless mass of rottenness. The same trucker has lost a large per cent of his carrots from bacterial decay, and this suggests the probable connection between the two diseases.

New Mexico Station, Bulletin No. 4, December, 1891 (pp. 21).

HORTICULTURAL NOTES, A. E. BLOUNT, M. A.—The soils of the Territory and the methods of irrigation and culture employed in fruit

growing are briefly described. Short notes are given on experiments with peaches, apples, pears, plums, cherries, apricots, figs, quinces, nectarines, nut trees, forest trees, small fruits, grapes, artichokes, asparagus, beans, beets, cabbages, cauliflowers, carrots, Chinese potatoes, chuna (check pea), celery, chufas, cucumbers, fenugreek, kohl-rabi, kale, mustard, onions, peanuts, potatoes, parsnips, peas, pumpkins, radishes, rhubarb, spinach, squashes, sunflowers, turnips, and tomatoes. There are also lists of the varieties planted as follows: 149 of peaches, 78 of apples, 56 of pears, 48 of plums, 16 of cherries, 20 of apricots, 2 of nectarines, 3 of quinces, 6 of figs, 8 of Japanese persimmons, 11 of nuts, 4 of currants, 4 of gooseberries, 7 of raspberries, 7 of blackberries, 4 of dewberries, and 98 of grapes.

Peaches, pears, plums, apricots, quinces, and grapes do well in this region. Pears bloom and bear fruit more than once a year. Cherries grow well but do not produce much fruit. Small fruits are grown with difficulty, except in shaded or damp places. Artichokes, asparagus, kohl-rabi, onions, peas, and rhubarb gave very satisfactory results. Beans, cabbages, celery, potatoes, and tomatoes are grown with difficulty. Insects are very injurious to beans, kale, pumpkins, and squashes.

New Mexico Station, Bulletin No. 5, March, 1892 (pp. 11).

NOTES ON IMPORTANT FRUIT INSECTS, C. H. T. TOWNSEND.—Popular accounts of the following insects, with suggestions as to remedies: Vine leaf hopper (*Typhlocyba vitis*), codling moth (*Carpocapsa pomonella*), root borers (*Prionus* spp.), and green June beetle (*Allorhina sobrina*).

North Dakota Station, Second Annual Report, 1891 (pp. 24).

Brief statements regarding the work of the station in different lines, and a financial report for the fiscal year ending June 30, 1892. The building recently erected for the use of the agricultural college and station is described and illustrated.

Ohio Station, Bulletin Vol. V, No. 2 (Second Series), February, 1892 (pp. 20).

MANGEL-WURZELS AND SUGAR BEETS, J. F. HICKMAN, M. S. A. (pp. 17–34, figs. 2).—For several years past the station has been conducting experiments in the culture of mangel-wurzels and sugar beets with reference to their value as feeding stuffs. The results are summed up in this bulletin under the following heads: (1) Comparison and classification of varieties, (2) transplanting, (3) continuous cropping with and without manure, (4) disposal of leaves, (5) suggestions for beginners in beet culture.

The yields of 19 varieties of mangel-wurzels and 7 of sugar beets are tabulated, as well as their average size and weight, and the percentages of dry matter. The mangel wurzels are classified according to

their shape into long red, ovoid, and globe varieties. The percentages of sugar in different varieties grown at distances of 20 and 33 inches apart are tabulated. The sugar content was low in both cases, ranging from 5 to 8 per cent. In 1890 it cost $37 per acre to raise the sugar beets and in 1891 $45.

The nature and results of the experiments reported are shown in the following summary:

(1) While new seed is not an absolute necessity to insure a crop of mangel-wurzels, it is better to use new seed if it can be had. Testing mangel-wurzel or sugar beet seed before planting is considered indispensable.

(2) In each class or variety of mangel-wurzels are found several strains, and while these do not differ materially, some have qualities that make them more desirable than others. In the long red class, the Giant Long Red has in a series of years seemed to have more vitality in the seed used, and has given a more satisfactory average growth than any other one of that class. The Giant Holstein, Dignity, and Jumbo have all made occasional higher yields than the Giant Long Red, and are among the best sorts in that class. The Giant Yellow Intermediate, Yellow Ovoid, and Yellow Leviathan are among the better kinds in the ovoid class. The globe class as a whole has been the least valuable type of mangel-wurzels.

(3) According to the experiments detailed in this bulletin, an acre of sugar beets, properly grown, is decidedly more valuable for feeding stock than an acre of mangel-wurzels.

(4) The sugar beets grown at this station during the past year have shown a percentage of sugar too small to justify growing them for sugar-making purposes.

(5) Transplanting mangel-wurzels has not been attended with satisfactory results, except in filling up rows to make a more perfect stand. Cutting off the leaves when transplanting has not been any benefit.

(6) Manuring land with fresh barnyard manure has been detrimental to the growing of mangel-wurzels and has in every case decreased the yield. Continuous cropping with mangel-wurzels has resulted in reducing the ability of the land to produce this crop by at least 10 per cent each year for the first 3 years.

(7) Preserving the leaves of mangel-wurzels and beets in the silo with corn silage has not been found practicable. It has been found possible to preserve them in a well or cistern in the ground with but little loss, but they were not relished by the stock, even when well kept. On account of the large proportion of fertilizing elements in the leaves it is advisable to leave them upon the ground.

Ohio Station, Bulletin Vol. V. No. 3 (Second Series), March, 1892 (pp. 23).

Field experiments with commercial fertilizers, C. E. Thorne and J. F. Hickman, M. S. A. (pp. 35–57).—*Experiments on corn* (pp. 35–52).—Experiments were made at the station on 22 tenth-acre plats which had been used for a similar purpose for 3 previous years. The treatment of these plats was similar to that described in Bulletin vol. III, No. 2 of the station (see Experiment Station Record, vol. II, p. 122). The yield of corn and stover, the increased yield with fertilizers, and the yields of the same plats in the 3 previous years are fully tabulated. The average yield of the unfertilized plats in 1891, which had received no fertilizers for 4 years, was 57.3 bushels per acre. The cost of the fertilizers is based on the retail prices in Baltimore January, 1892, adding $5 per ton for freight.

(1) On the fertile soil on which this experiment is being conducted there is no sufficient evidence as yet that phosphoric acid and potash are of any benefit in a fertilizer for corn, until combined with nitrogen.

(2) In 1890 and 1891 some increase has followed the use of nitrogen in every case, but in 1888 there is no evidence that nitrogen, whether used alone or in combination with phosphoric acid, has produced any increase of crop beyond the limits of probable variations in the soil itself, until we reach plats 17, 18, 20, and 21, and on these plats the apparent increase is insignificant when compared with the great superiority shown in the yield of the unfertilized plats of that season over that of the same plats in any subsequent season.

The results are also reported of experiments with fertilizers for corn on 5 private farms in as many counties.

The results are variable, but they agree upon two points; these are: (1) Nitrate of soda in combination with dissolved boneblack or muriate of potash, one or both, has produced an increase of crop in 46 out of 48 trials, or practically in every case; (2) in no case has the average increase of crop from this combination in any one of the six series of experiments been sufficient to pay the cost of the fertilizer at present prices of corn and fertilizers, respectively.

The experiments justify the inference that there may be exceptional soils in Ohio, upon which superphosphate and potash without nitrogen will produce a larger increase than they have shown in the average of these tests, but the evidence on this point is not conclusive, and the fact that in 20 out of 46 trials in which superphosphate and potash were used without nitrogen there was no increase of crop, should lead the farmer to experiment carefully before adopting this system of partial fertilizing.

Experiments on oats (pp. 52–55).—These were on 22 plats and were in continuation of the experiments in 1889 and 1890, the plan of which was described in Bulletin vol. III, No. 1 of the station (see Experiment Station Record, vol. II, p. 124). The yields are tabulated of grain and straw on the plats in 1889, 1890, and 1891, and the increased yields with fertilizers.

"The fertilizers apparently produced an increase of crop in practically every case, the increase being more uniform when the fertilizer contained nitrogen, but at present prices of grain and fertilizers, respectively, the average increase has in no case been sufficient to pay the cost of the fertilizer."

Fertilizers on crops grown in rotation (pp. 55–57).—To study the economy of fertilizers in a rotation of crops, 5 blocks of 7 twentieth-acre plats each were used. Upon these blocks corn, oats, wheat, and a mixture of clover and timothy followed each other in the order named, the clover and the timothy occupying the land 2 years. The corn and wheat crops received mixtures of 300 pounds of superphospates and 160 pounds of muriate of potash, with and without 160 pounds of nitrate of soda per acre, and 8 tons of barnyard manure per acre. The yields are tabulated for 1891.

The experiments on crops grown in rotation have not yet been carried over a sufficient length of time to justify general conclusions, but thus far they offer no more encouragement to the use of chemical manures than those on crops grown continuously.

A very wide difference is indicated in the value of stable manure according as it is used fresh from the stable or after half a year's leaching in the barnyard. Apparently the margin of profit in the use of open-yard manure is extremely meager.

Ohio Station, Bulletin Vol. V, No. 4 (Second Series), April, 1892 (pp. 28).

INSECTS WHICH BURROW IN THE STEM OF WHEAT, F. M. WEBSTER (pp. 59–84, figs. 18).—Historical accounts of observations on the following insects, with suggestions as to means of repression: Joint worm (*Isosoma hordei*), wheat straw worm (*Isosoma tritici*), wheat stem sawfly (*Cephus pygmæus*), grain sphenophorus (*Sphenophorus parvulus*), stalk borer (*Gortyna nitela*), wheat stem maggot (*Meromyza americana*), companion wheat fly (*Oscinis* sp.), American fritfly (*Oscinis variabilis*?).

Oregon Station, Bulletin No. 18, March, 1892 (pp. 16).

INSECTS INJURIOUS TO YOUNG FRUIT TREES, F. L. WASHBURN, B. A. (figs. 14).—Popular accounts of the following insects, with suggestions as to remedies: San José scale, oyster-shell scale, woolly aphis, Western peach tree borer (*Sannina pacifica*), flat headed apple tree borer, green aphis (*Aphis mali*), peach aphis (*Myzus persicæ*) and plum aphis, pear and cherry tree slug, peach moth, white marked tussock moth, cutworms, flat-headed peach and cherry borer (*Buprestis divaricatus*), red spider (*Tetranychus telarius*), tent caterpillars, cankerworms, branch and twig borer, unicorn prominent, plum tree catocala, red-humped caterpillar, locusts, scolytid borers, round-headed apple tree borer, pear blight beetle, Glover's scale, purple, lemon, and white scales, wireworms, flea beetles, and the codling moth. Formulas are given for kerosene emulsion.

Pennsylvania Station, Bulletin No. 19, April, 1892 (pp. 13).

SPRAYING FRUITS, G. C. BUTZ, M. S. (figs. 6).—Popular information on the preparation and use of insecticides and fungicides, with illustrated descriptions of spraying apparatus.

Rhode Island Station, Bulletin No. 15, April, 1892 (pp. 25).

LOOSE SMUT OF OATS, C. O. FLAGG, B. S. (pp. 3–10, figs. 3).—Compiled information regarding the nature and treatment of loose smut of oats (*Ustilago avenæ*).

FUNGICIDES AND INSECTICIDES, L. F. KINNEY, B. S. (pp. 11–25, figs. 6).—Compiled information, including formulas for fungicides and insecticides, and notes on spraying and other apparatus, and on the treatment of black rot of grapes, apple scab, codling moth, cankerworm, and plum curculio.

South Dakota Station, Bulletin No. 27, November, 1891 (pp. 68).

SUGAR BEETS IN SOUTH DAKOTA, J. H. SHEPARD, M. A.—An account is given of tests of beet mothers selected in 1890 from beets of

different varieties grown on the station farm. From the small number planted a good yield of seed was obtained. From this it is hoped to produce seed for distribution. Notes and tabulated data on culture and the results of analysis are reported for 263 samples of beets received from different parts of the State.

Of the 263 analyses, 55 show under 10 per cent of sugar in the beet; of these, 13 show 10 per cent and over of sugar in the juice. Eighty-four show between 10 and 12 per cent sugar in the beet; of these, 34 show 12 per cent and over of sugar in the juice and are consequently of marketable value. Seventy-nine show over 12 per cent and under 15 per cent of sugar in the beet; of these, 41 show over 13 per cent of sugar in the beet. Forty-five show over 15 per cent of sugar in the beet; of these, 8 show over 17 and 2 show over 18 per cent of sugar in the beet.

Mistakes in culture or the selection of samples for analysis are stated to account for the low percentages of sugar found in many cases. The soil and climate of the State are favorable to the growth of the sugar beet.

South Dakota Station, Bulletin No. 28, December, 1891 (pp. 35).

Irrigation, L. Foster, M. S. A., and C. A. Duncan, B. S. (figs. 5).—General information is given regarding methods of irrigation and the amounts of water to be applied to different crops. A preliminary report is made of experiments under direction of the station at Mellette, Frankfort, and Huron, South Dakota. The water used was obtained from artesian wells. Experiments indicate that irrigation may be advantageously used in the James River Valley for cereals and other crops.

Texas Station, Bulletin No. 20, March, 1892 (pp. 14).

A study of the composition of grasses, H. H. Harrington, M. S. (pp. 179–185).—This includes descriptions by the author and analyses by D. Adriance of samples of Johnson grass (*Sorghum halepense*), rescue grass (*Bromus unioloides*), alfalfa, and burr clover (*Medicago maculata?*), cut at different stages of growth, and of the ash of alfalfa.

Contribution to the composition of American grains, H. H. Harrington, M. S. (pp. 186–189).—Analyses of a large number of samples of corn, oats, wheat, rye, and barley, and of the ash of wheat, oats, rye, barley, and dhoura corn.

Water analyses, H. H. Harrington, M. S. (p. 190).—Analyses of six samples of well and mineral waters.

Vermont Station, Bulletin No. 27, January, 1892 (pp. 12).

Tests of dairy apparatus, J. L. Hills, B. S.—This bulletin describes the tests made in connection with the dairy school of the University of Vermont and State Agricultural College, which was held at Burlington in December, 1891. The dairy school was well equipped with the newest forms of apparatus, including butter workers, churns,

milk cooler and aërator, and separators. About 1,000 pounds of milk were handled daily. The results of the tests of separators are tabulated. The following notes on the working of the apparatus are taken from the bulletin:

The De Laval belt separator.—This machine was used the least of all, and there is but one record of its skim milk and none of buttermilk. The skim milk shows 0.08 per cent of fat when the machine was making 6,075 revolutions per minute and skimming 1,057 pounds of milk per hour, at a temperature of 76° F.

The De Laval turbine separator.—This was used four times, with the following average record: Revolutions per minute 5,900, pounds of milk per hour 1,976, temperature of milk 80° F., average per cent of fat in skim milk 0.08, and, throwing out the single high buttermilk, the average for the other buttermilks is 0.16 per cent of fat.

The Sharpless Russian steam separator.—This was used twice, making 7,300 revolutions per minute, skimming 1,000 pounds of milk per hour at a temperature of 81° F., with an average skim milk of 0.23 and an average buttermilk of 0.14 per cent of fat.

The Danish-Weston separator.—This was used three times, with an average speed of 4,300 revolutions per minute, skimming 1,385 pounds of milk at 79° F.; the skim milk contained on the average 0.1 per cent of fat and the buttermilk 0.08.

The extractor was used as a separator twice, making 6,950 revolutions per minute, skimming 1,867 pounds of milk per hour at a temperature of 85° F., and there was left on the average 0.14 per cent fat in the skim milk and 0.1 in the buttermilk.

The extractor was used five times as an extractor, at a speed of 5,800 revolutions per minute, with the milk at 59° F., leaving in the skim milk 0.24 per cent of fat.

This per cent of fat in the skim milk is of more importance in the extractor than in the other machines, because each of the wash waters of the butter is run back through the machine, making the final quantity of the skim milk larger than the combined weight of the skim milk and buttermilk of other separators.

The De Laval hand separator.—The size used was the Baby separator No. 2. This has been run at speeds varying from 6,000 to 8,000 revolutions per minute, skimming 330 pounds of milk per hour at temperatures from 70° to 95° F., and the per cent of fat in the skim milk does not seem to be influenced by these changes of speed or temperature, keeping very closely to 0.1 per cent. * * *

Churns.—Both the box and the barrel churn were used, and so far as we could see there was no difference in the character of their work. The average fat in the buttermilk from the box churn was 0.14 per cent, and from the barrel churn 0.13.

Butter workers.—All three butter workers did good work and gave satisfaction, the principal interest being in the operation of the Mason and of the Fargo. An examination of the tests shows that there was practically no difference in the moisture in the butter from the two workers, and the men who used them were surprised to find that there was also little if any difference in the work of washing them and keeping them clean.

Aërator.—The Heuling cooler and aërator gave good satisfaction, and a special test showed that in a room of 54° F. temperature it is possible to cool down 100 pounds of milk from 82° to 44° with 417 pounds of water at 39°, and that it is possible with the use of a comparatively small quantity of water to bring the cream to within a degree or so of the temperature of the water. * * * The extractor butter had the most water, that churned sweet next, and the ripened butter still less, while one sample made from cream kept 48 hours had a very small per cent of water.

Vermont Station, Bulletin No. 28, April, 1892 (pp. 24).

PLANT DISEASES, L. R. JONES, B. S. (pp. 15–36, plate 1).—The subjects treated are (1) potato blight and rot, (2) a new potato disease, (3) potato scab, (4) apple and pear scab, (5) oat smut.

Potato blight and rot (pp. 17–24).—Accounts are given of successful experiments with Bordeaux mixture for potato blight and rot at the station and in different localities in the State, in continuation of those reported in Bulletin No. 14 of the station (see Experiment Station Record, vol. III, p. 101). The gain in yield much more than repaid the cost of spraying, which is estimated at $2.50 per acre for each application. It is recommended to dig the potatoes as soon as practicable after the tops are blighted.

A new potato disease (pp. 25–27).—A brief account of a disease of potatoes prevalent in Vermont in 1891. The differences between blight and this new disease are stated as follows:

(1) The blight attacks the leaf at any point and generally works rapidly; in the new disease the leaf begins dying at the tip and dies slowly backward, the leaf drying and curling meanwhile, and the whole progress of the disease is comparatively slow.

(2) In the true blight the black spots on the leaves are fringed on the under side by a delicate fungous growth; in the new disease this is never found.

(3) The true blight may be expected in the latter part of the summer, especially in August, and only during warm, wet weather; the new disease may be expected earlier, and develops in cooler and dryer weather.

(4) Following the blight the tubers may be expected to show more or less of rot, especially of the dry rot, if the soil is heavy or moist. No such rotting of the tubers occurred last year in Vermont as a consequence of the new disease.

Bordeaux mixture was used for its repression without any marked effect.

Potato scab (pp. 28–30).—A brief summary of information compiled from the Annual Report of the Connecticut State Station for 1891 and Bulletin No. 4 of the North Dakota Station (see Experiment Station Record, vol. III, pp. 619 and 771).

Apple and pear scab (pp. 30–34).—Brief accounts of experiments in which ammoniacal carbonate of copper was used on pear and apple trees and Bordeaux mixture on apple trees. Both fungicides largely reduced the amount of scab, but Bordeaux mixture is preferred for the following reasons:

(1) The dilute Bordeaux mixture is a little cheaper than the ammoniacal copper carbonate.

(2) Paris Green for the codling moth may be mixed with the Bordeaux mixture, but when mixed with the ammonia solution is liable to burn the leaves.

(3) The Bordeaux mixture is not easily washed off by rains.

On the other hand the ammoniacal solution has no sediment and hence is more easily applied and does not leave any trace of the copper salt on the fruit. It may be preferable, therefore, for the last application to use the ammoniacal solution.

Oat smut (pp. 34–36).—Brief statements regarding the prevalence of oat smut in Vermont and the hot water method for its repression.

West Virginia Station, Bulletin No. 22, February, 1892 (pp. 37).

WEEDS OF WEST VIRGINIA, C. F. MILLSPAUGH, M. D. (pp. 177–212).—This is in continuation of the article in Bulletin No. 19 of the

station (see Experiment Station Record, vol. III, p. 629). On the basis of information furnished by 284 observers in different parts of the State, tabulated data are given regarding the distribution, prevalence, and troublesomeness of the species of weeds found in West Virginia. There are also brief statements regarding the value of some of these weeds as forage plants, and the use of chemicals as weed exterminators. The 25 species considered the "worst weeds" are as follows: Ox-eye daisy (*Chrysanthemum Leucanthemum*), broom sedge (*Andropogon scoparius*), pasture thistle (*Cnicus lanceolatus*), burdock (*Arctium lappa*), bitter dock (*Rumex obtusifolius*), wild carrot (*Daucus carota*), elder (*Sambucus canadensis*), ironwood (*Vernonia noveboracensis* and *V. altissimus*), yarrow (*Achillea millefolium*), buck plantain (*Plantago lanceolata*), cocklebur (*Xanthium canadense*), blue thistle (*Echium vulgare*), ragweed (*Ambrosia artemisiæfolia*), Spanish needles (*Bidens bipinata*), whitetop (*Erigeron annuus*), sand briar (*Solanum carolinense*), sorrel (*Rumex acetosella*), garlic (*Allium vineale*), white devil (*Aster lateriflorus*, var. *hirsuticaulis*), blue devil (*Aster cordifolius*, var. *lævigatus*), Canada thistle (*Cnicus arvensis*), morning glory (*Ipomœa purpurea*), wild sweet potato (*Ipomœa pandurata*), dog fennel (*Anthemis cotula*), cinquefoil (*Potentilla canadensis*).

ABSTRACTS OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

FARMERS' BULLETIN NO. 8.

INOCULATION FOR THE PREVENTION OF HOG CHOLERA, D. E. SALMON (pp. 40).—A popular account of the experiments made by this Department and elsewhere with reference to the protection of swine against hog cholera, including a report on the test conducted in La Salle County, Illinois, in 1891, under the supervision of a committee of farmers. The conclusion is reached that inoculation as a preventive against hog cholera is a failure from whatever point of view it be regarded, and the farmers are warned against the use of that method, which is shown to have been in many cases more fatal than the disease it is intended to prevent. As an instance of this the fact is stated that whereas the losses following inoculation in Nebraska during 1891 were 10 per cent the losses among uninoculated animals were but 4 per cent.

WEATHER BUREAU.

CIRCULARS B AND C, INSTRUMENT ROOM.

INSTRUCTIONS FOR THE USE OF MAXIMUM AND MINIMUM THERMOMETERS AND THE RAIN GAUGE (pp. 10 and 8, figs. 6 and 3).—Illustrated descriptions of these instruments and detailed directions for their use.

OFFICE OF EXPERIMENT STATIONS.

EXPERIMENT STATION BULLETIN NO. 8.

LECTURES ON THE INVESTIGATIONS AT THE ROTHAMSTED EXPERIMENTAL STATION, R. WARINGTON, F. R. S. (pp. 113, plates 11).—These lectures were delivered under the provisions of the Lawes Agricultural Trust before the Association of American Agricultural Colleges and Experiment Stations, at Washington, D. C., August 12-18, 1891, and are the first of a series to be delivered biennially in the United States, in order that "Americans should feel that 'they have a share' in any benefits which may arise from the Rothamsted endowment."

The subjects treated are: (1) The Rothamsted Experimental Station, (2) the circumstances which determine the rise and fall of nitrogenous matter in the soil, (3) nitrification, (4) nitrification and denitrification, (5) nitrification of soil and manures, (6) drainage and well waters. A list of Rothamsted papers referred to in the lectures is given in an appendix.

Lecture I.—The Rothamsted Experimental Station (pp. 7–21).—This gives a general account of the origin, history, plans, and results of experimental work at Rothamsted, and is devoted to practically the same subjects as those covered by a pamphlet issued by that station in June, 1891, an abstract of which will be found in Experiment Station Record, vol. III, p. 73. In addition the endowment and managers of the Lawes trust are given.

Lecture II.—The circumstances which determine the rise and fall of nitrogenous matter in the soil (pp. 22–41).—"Nitrogen of soils exists in three very different forms of combination, (1) as ammonia, (2) as nitrates, and (3) as nitrogenous organic matter. The ammonia is generally insignificant in amount. Although itself a proper food for plants, it is only seldom that it has any importance from this point of view, owing to its rapid conversion into nitric acid. The quantity of nitrates present in the soil is usually far more considerable than that of ammonia, though it is very rarely that 5 per cent of the total nitrogen of the soil exists in this state. * * * The great bulk of the nitrogen contained in soil occurs in combination with carbon and the elements of water, forming the so-called humic compounds or nitrogenous organic matter of the soil."

The nitrogenous matter of soil is the residue of former animal and vegetable life and there are probably very few sedimentary rocks which do not contain an appreciable amount of nitrogen. Borings of calcareous clay (Oxford) from a depth of about 500 feet below the surface showed 0.04 per cent of nitrogen. The examination of samples of Rothamsted subsoils, taken in many cases at as great a depth as 9 feet, show that while there is a variation in different places of from 0.03 to 0.06 per cent of nitrogen, there is no indication that it diminishes as we descend after a certain distance from the surface has been reached. "The nitrogen of this deep subsoil is to be regarded as in great part of ancient origin, belonging in fact to the clay when originally deposited. A sandy subsoil is usually poorer in nitrogen than one of clay. The nitrogenous matter of our surface soils, with which agriculture is chiefly concerned, is undoubtedly in greatest part of modern origin, and the processes which bring about its accumulation and diminution are at the present day in progress under our own eyes and deserve our most careful study."

The production or accumulation of nitrogen in the surface soil is illustrated by tabulated analyses of Rothamsted and Manitoba soil at depths varying in the first case from 9 inches to 9 feet, and in the second from 1 to 4 feet. "With undisturbed soils lying in natural prairie

or farm pasture the difference between the proportion of nitrogen in the surface soil and in the subsoil is far greater than in the case of arable land, and the line dividing the surface soil and subsoil is generally sharply drawn." In the case of the growth of legumes this increase is very striking. "The facts point to a considerable and long-continued gain of nitrogen in the surface soil when arable land is laid down under favorable conditions in permanent pasture, and to a gain of nitrogen in the soil, or to its utilization by crops from sources beyond the surface soil when leguminous plants are cultivated either alone or as members of a rotation." Whether this increase comes to an appreciable extent from the subsoil, numerous determinations of nitrogen in the subsoil have not definitely decided. From observations at Rothamsted, Lincoln (New Zealand), and in Barbadoes it was found that 3.37, 1.74, and 3.77 pounds of nitrogen per acre, respectively, was brought down in rain, snow, etc., annually. "It is evident that if the ammonia and nitric acid of the air are to be of any considerable agricultural importance they must be taken up directly by crop or soil to an extent far beyond that which takes place through the medium of rain. The amount of ammonia and nitric acid in the air is certainly extremely small, but the air that is in contact with crop and soil is being constantly renewed. It is therefore by no means impossible that the quantities absorbed may become considerable." The direct absorption of ammonia, nitrites, and nitrates from the air by the soil and crop, and the fixation of free nitrogen are discussed at some length. "For the present we can not, I think, affirm that soils are enriched by the free nitrogen of the air except through the medium of a leguminous crop."

There is a limit, however, to this accumulation of nitrogen both with permanent pastures, with leguminous crops, and with arable land receiving every year a liberal dressing of barnyard manure. Tabulated data showing the decrease of nitrogen in Rothamsted soils under different conditions of culture are given, and the causes of their losses are discussed.

The addition of organic matter to a soil either as crop or weed residue or as farmyard manure at once makes that soil a suitable home for the animal life, the fungi and the bacteria, whose function it is to reduce organic matter to the condition of inorganic matter. An increase of organic plant residue or manure thus creates some of the conditions favorable to its own destruction. The rate of oxidation in the soil is now no longer what it was; the oxidizing agents have increased with the material to be oxidized. If, therefore, a soil is laid down in pasture or receives an annual dressing of farmyard manure, the nitrogen in that soil will only increase so long as the annual increment of organic matter exceeds the annual decrement of oxidation. If this increment is a limited quantity it will be met before long with an army of destroyers competent to effect its destruction. The richest soils are thus most liable to waste and demand the greatest exercise of the farmer's skill to preserve their condition.

When the conditions of the soil are changed, as when the pasture is plowed up or the arable land is left without manure, there is at first a rapid loss of soil nitrogen, but the rate of loss soon diminishes. The army of oxidizing organisms has been reduced by starvation. The organic matter most easily attacked has disappeared. A

partial equilibrium is established when the annual destruction of organic matter amounts to little more than the annual residue of crop and weeds, but an absolute equilibrium is reached only when the annual loss of nitrogen is equaled by the atmosphere supply. In every case nature seeks to establish an equilibrium.

The method of soil sampling practiced at Rothamsted is described and discussed.

Lecture III.—Nitrification (pp. 42–59).—The natural sources and the artificial production of niter are described. The conditions favorable to nitrification have been understood for many years and applied in the manufacture of niter. The theories formerly held regarding nitrification were that it is due to oxidation of nascent nitrogen or of ammonia by the oxygen of the air, ozone, or peroxide of hydrogen. Pasteur first advanced the idea that this process is due to a living organism, and in 1873 Müller suggested that the rapid change of ammonia into nitric acid in sewage is due to the action of a ferment, but "to the French chemists Schlösing and Müntz belongs the credit of establishing by experiment the true nature of nitrification." At the time that their results were announced experiments in the same line were in progress in the Rothamsted laboratory. These were continued with the result of confirming the previous conclusions of Schlösing and Müntz.

It was shown that (1) the power of nitrification could be communicated to mediums which did not nitrify by simply seeding them with a nitrified substance; (2) the process of nitrification in garden soil was entirely suspended by the presence of the vapor of chloroform or carbon disulphide. These two facts taken together clearly pointed to a living agent as the cause of nitrification. It was also shown that light is unfavorable to its action.

The conditions necessary to nitrification are discussed at some length. These have been found to be the presence of phosphates, a liberal supply of oxygen, a salifiable base, a suitable temperature (about 37° C.), and the absence of strong light.

For the nitrification of ammonium salts, urea, or other nitrogenous matter to be complete, some salifiable base must be present. The substance which usually plays this part in soil is calcium carbonate. A soil which contains little or no available base is sure to be very deficient in fertility. Such soils are greatly benefited by dressings of chalk or lime.

Although an alkaline condition of the medium is essential for nitrification, the presence of anything beyond a small proportion of soluble alkali is a hindrance to the process, and a large amount will prevent the action altogether. * * *

A heavy dose of lime applied to land may thus suspend for a time the process of nitrification in the surface soil, but this action will soon cease as the lime unites with carbonic acid, and the final result will be favorable to nitrification if the land was originally deficient in lime.

By a simple chemical expedient it is possible to diminish the alkalinity of liquid manure or other liquids containing alkali carbonates, and thus render them suitable for nitrification; this may be done by the addition of gypsum (*Trans. Chem. Soc.*, 1885, 758).

Experiments by Dr. J. M. N. Munro and also by the author suggested that the nitrifying organisms could subsist on purely organic food, but to Winogradsky is due the credit of supplying actual proof of the fact

(see *Ann. de l'Inst. Pasteur*, 4 (1890), pp. 213, 257, 760; and 5 (1891), p. 92; and also Experiment Station Record, vol. II, p. 751).

That an organism unprovided with chlorophyll and growing in darkness should be able to construct organic matter out of ammonium carbonate, is certainly a fact of the highest interest. The process would seem to us an impossible one but for the energetic oxidation of ammonia, which forms part of it; by this oxidation so much energy is developed that the nutrition of the nitrifying organism by ammonium carbonate becomes part of a strongly exothermic reaction. * * *

As soon as the fact had been established that nitrification was the work of a living organism it became important that this organism should be isolated and its properties studied. * * * The first successful attempt at isolation was made by Dr. P. F. Frankland (*Phil. Trans. Roy. Soc.*, 1890, B. 107). * * * Two months afterwards Winogradsky published an account of his isolation of the same organism (*Ann. de l'Institut Pasteur*, 1890, 213). * * * Later in the same year I also succeeded in obtaining a similar result (*Trans. Chem. Soc.*, 1891, 502).

This organism, which is described and illustrated, proved to be a purely nitrous ferment.

Lecture IV.—Nitrification and denitrification (pp. 60–76).—As early as 1881 the author was in possession of cultures which possessed the power of converting nitrites into nitrates, but only until recently was he successful in separating the nitric organism in the pure state (*Trans. Chem. Soc.*, 1491, 484). Still more recently Winogradsky has announced the isolation of a nitric organism by culture on gelatinous silica (*Compt. rend.*, 113 (1891), and Experiment Station Record, vol. II, p. 751). This organism is described and its properties discussed. Like the nitrous ferment, it grows freely in inorganic nutrient solutions, but appears to be without action on ammonia, while it readily converts nitrites to nitrates. "The facts as at present ascertained lead us to believe that the nitrification of ammonia in soil, and probably also the nitrification of other nitrogenous matters, takes place in two stages, each stage being performed by a distinct organism. By one organism the ammonia is converted into nitrite, by the other the nitrite is converted into nitrate."

In soil containing a sufficient amount of oxidizable organic matter and an insufficient supply of oxygen (as in the case of water-logged soils) processes of denitrification take place. The most common form of action is a reduction of nitrates to nitrites, but in some cases the reduction is carried further, resulting in the production of nitric oxide, nitrous oxide, and free nitrogen.

Denitrification is not a process of general occurrence in arable soil. The investigations which have been made show that the air in soil, even at considerable depths, is not very deficient in oxygen. Moreover the subsoils of our fields contain (save in the case of peaty and some alluvial soils) only a very small amount of organic matter, and the presence of this, we have seen, is indispensable for the reduction of nitrates. The reduction of nitrates is to be feared only when the soil has been for some time saturated with water.

Experiments made at Rothamsted in 1883, 1884, 1885, and 1886 (*Trans. Chem. Soc.*, 1884, 645; 1887, 118) respecting the depths to which the nitrifying organism can be found in the soil, showed "that the nitrous organism was present in almost every trial down to 3 feet below

the surface. * * * In one series of trials the observation of the solution was continued till conversion of nitrites to nitrates was complete. This certainly occurred with all soils down to 4 feet below the surface."

It is of interest to note in this connection that Müntz has found the nitrifying organisms in the disintegrating rocks of the Alps (see Experiment Station Record, vol. III, p. 114).

The methods used by the author for preparing soil extracts and determining the nitrates in the same are described. Details of the latter (a modification of Schlösing's method) will be found in *Trans. Chem. Soc.*, 1880, 468; 1882, 345, 351.

The quantity of nitrate which may be formed in soil under favorable circumstances is very large, and the process of nitrification very rapid. The most striking instance I am aware of is furnished by one of Schlösing's experiments, in which * * * during the 12 days of active nitrification, nitrogen was oxidized at the rate of 56 parts per million of dry soil per day.

The greatest rate of nitrification I have noticed when working with ordinary arable soil (first 9 inches) from the Rothamsted farm, has been about 70 parts of nitrogen per million of air-dried soil in 119 days (0.588 per day). * * *

Lawes and Gilbert (*Trans. Chem. Soc.*, 1885, 415) working with the far richer Manitoba soils and with a higher temperature, obtained in two cases (soils from Selkirk and Winnipeg) average daily rates of nitrification of 0.7 part of nitrogen per million during 335 days, the rates during the earlier portion of this period being as high as 1.03, 1.24, 1.36, and 1.72 per million. The greatest proportion of nitrogen nitrified in 335 days was 5.4 per cent of that originally present in the soil.

Dehérain (*Ann. Agron.*, 1887, 245; 1888, 292) working with a soil containing 0.16 per cent of nitrogen, obtained daily rates of nitrification varying from 0.71 to 1.09 per million in 90 days.

[The amount of nitrogen as nitrates at depths of from 9 to 27 inches in Rothamsted soils after bare fallow, are given in a table. If we add to the amount thus determined that found in the drainage water,] we arrive at 86.5 pounds of nitrogen per acre as the quantity nitrified during the season of 1881–82, and 89.5 pounds as the amount nitrified in 1880–81 (the periods covered in each case being from 14 to 15 months). * * * If a farmer could insure dry seasons, so that the nitrates produced during a bare fallow should remain in the soil available for the succeeding crop, it would pay him better to have an alteration of wheat and dry fallow rather than to grow wheat continuously, but in the English climate no such favorable result can be expected [and 30 years' experiments at Rothamsted have shown that] wheat after fallow, except in some of the earliest years, has not given the double produce which should result from the presence of a double supply of nitrates. It is also further evident that the fallowed land has declined in fertility more quickly than the land which has been continuously cropped.

The construction of the drain gauges in use at the station is described. These gauges have brought out the remarkable fact "that a poor, arable soil, without vegetation, loses annually by drainage nitrates equivalent to 2 cwt. per acre of sodium nitrate."

Lecture V.—Nitrification of soil and manure (pp. 77–94).—The average monthly amounts of drainage, and nitrogen as nitrates in drainage water, from unmanured bare soils, 20 and 60 inches deep, for 13 years, and from unmanured wheat land for 12 years, are given in tables. In the first case the drainage from 60 inches of soil was only

0.4 inch less than that from a soil 20 inches deep; the amount of drainage was greatest in December and least in July; the proportion of nitrates in the drainage was generally greatest in September and least in March, this proportion being much more uniform throughout the year in the 60-inch than in the 20-inch soil; the total quantity of nitrogen as nitrates removed in the drainage water was greatest in November and least in April.

In the second case it was observed that when the spring is a forward one, as in 1884, the nitrates may disappear from the drainage of the unmanured wheat plat in March; in other years the disappearance has occurred in April or May. In June it is rare to find nitrates in this drainage water. * * * In September, the crop being now removed, nitrates are always found in the drainage water. In a wet season the maximum amount of nitrates will occur in October. The proportion of nitrates will be maintained with little diminution during the winter months and begin to fall again in March. * * * These facts not only illustrate the effect of a growing crop in removing nitrates from the soil, but they also point out the great defect of cereal crops, considered as conservers of soil nitrogen. The active growth of cereal crops ceases generally in July and they are entirely removed from the land in August or September; they are thus unable to afford protection against loss of nitrates during the autumn months, the season at which the greatest losses occur. From this point of view maize is a more economical crop than either wheat, oats, or barley, its growing period extending through the whole of the summer. Nor must we forget that the need which a crop has for nitrogenous manure is in inverse proportion to its own power of assimilating nitrogen. After a wet winter cereal crops begin to grow in a soil impoverished of its nitrates, and the growth of most cereal crops is over before the summer production of nitrates is half accomplished. Cereal crops are thus especially benefited by nitrogenous manures, and particularly by the application of nitrates, while, for the reason already given, maize is more independent of such manuring than wheat or barley. The beneficial influence of a dry winter upon the crops of the ensuing year is now generally recognized.

Experiments for a number of years with leguminous crops, the results of which are tabulated, indicate "that the average proportion of nitrates in the drainage water passing through a soil growing leguminous crops will generally be greater than in cases where cereal crops are grown. * * * The drainage water being richer, the proportion of nitrates in the subsoil out of reach of the changes produced by crop and season, will also be greater."

The desirability of practicing rotations which keep the land under crop continuously in order to conserve the nitrates, is urged.

The amount of nitrates in the drainage water from plats cropped with wheat and variously manured, and in the soil of plats variously manured and cropped with wheat and barley, are tabulated and discussed.

The most striking results we observe are (1) that manuring with ash constituents alone increases the production of nitrates in the soil; (2) that the bigger crops grown by ammonium salts or sodium nitrate, with ash constituents, are followed by an increased production of nitrates; (3) that the use of an organic manure like rape cake or farmyard manure is attended with a large increase in the production of nitrate, even after the first active stage of nitrification is long past. * * *

The manures most readily nitrified by a fertile soil are the salts of ammonia [and it is with these that the phenomenon has been most thoroughly studied. The

composition, as tabulated, of the drainage water of a plat before and after application of ammonia salts shows that] only 40 hours after the application of the ammonia, nitrification has made a distinct commencement, and the proportion of nitrate increases in the successive drainage waters obtained, the maximum of nitrate (50.8 parts per million) being reached 3 weeks after the application of the ammonia. [The most complete experiments on this subject are those by Schlösing (*Chim. Agricole*, 165, and *Compt. rend.*, 109, 423].

The nitrification of manures other than ammonium salts has at present been very insufficiently studied. Perhaps the most interesting of recent experiments are those by Müntz and Girard (*Ann. Agron.*, 1891, 289). These investigators place guano next to ammonium salts in the order of nitrifiability; following guano come green manures (lucern and lupines), which, compared with other forms of manure, appeared to be especially active in clay soils; the third class includes dried blood and meat, and powdered horn; far below these stand poudrette, wool, and leather.

Lecture VI.—Drainage and well waters (pp. 95–112).—In soils in which there is no movement of water (a very rare condition) the movements of the dissolved salts are determined simply by the laws of molecular diffusion. While the movement from this cause is considerable, far more rapid changes are produced when the soil water is in motion. To study this subject, 223 mg. of sodium chloride were applied to the surface of a saturated column of soil free from chloride, 8 inches deep and 4.5 inches wide. At the end of a week 120 c. c. of water was daily placed on the soil and nearly an equal quantity of drainage water obtained and analyzed.

[It appears] that during the first 3 days the drainage water obtained was free from chlorine. On the fourth day, something less than 471.8 grams of drainage water having passed, the discharge of the chlorine commenced. We have here at once evidence of the downward diffusion of the chloride during the 11 days that had passed since its application. If no diffusion had taken place and the chloride had remained at the surface, it would have required the application of 850 grams of water to cause its appearance in the drainage, this being the amount of water necessary to displace the water already held by the soil. The chloride having already descended a considerable distance, the displacement of about 400 grams of water was sufficient to bring some of it into the drainage water. * * *

It took 8 days to remove all chloride from the soil and the drainage water containing chlorine amounted to 950.1 grams, a quantity in striking contrast with the 150 grams of drainage in which the whole of the chlorine was contained when water was quickly drawn through a similar weight of air-dried soil by the air pump.

On looking at the strengths of the successive runnings, it will be evident that the chloride came through the soil as a wide band, diffusing both at its lower and upper edges. This is the usual mode in which diffusible salts descend through a soil, and a knowledge of this fact is essential if we are to understand the results of the analyses of drainage waters collected within a moderate distance of the surface.

[In natural soils, however, drainage is not simply a matter of diffusion and displacement. The process is complicated] by the fact that such soils always contain a multitude of fissures, consisting of cracks in the soil and channels formed by worms or left by decaying roots. These fissures communicate directly with the surface, and down them water passes which has never permeated the whole mass of soil. The result is that the drainage collected at a moderate distance below the surface is a mixture of two waters of different composition, and at different periods in the running one or other of these waters will greatly preponderate.

Observations of the change in composition of drainage water from 2 plats on which ammonium salts were applied on March 12 and October 25 serve to illustrate this fact, as well as to show that the chlorides are a more reliable index of the movement of soluble salts in the soil than the nitrates.

The principal constituent in drainage water is calcium carbonate. Application of fertilizers, especially ammonium salts, increases the proportion of this ingredient.

If we take the mean of ten series of analyses of drainage waters by Voelcker and Frankland (1866–73), and assume the average drainage in Broadbalk field as 10 inches per annum, we have 223 pounds of lime and magnesia as the annual loss per acre upon the unmanured plat; 297 pounds on the plat receiving superphosphate, with sulphates of potassium, sodium, and magnesium; 284 pounds on the plat receiving sodium nitrate, with half a dressing of superphosphate and alkali sulphates; 389 pounds on the plat manured with ammonium salts only; 443 pounds where superphosphate is used with the ammonium salts; and a mean of 485 pounds where alkali sulphates are also applied.

Potash and phosphoric acid were present in only small quantities (3.6 and 2.1 pounds per acre, respectively, for 10-inch drainage), and it is probable that without drainpipes the greater part of both would be retained in the soil. Soda was present in large quantity, as soils have slight retentive power for this constituent.

The average proportion for 5 years of nitrogen as nitrataes in drainage waters of 12 plats differently manured, is given in a table. In the case of plats receiving nitrogenous manure, "the spring period shows a considerable diminution in the amount of nitrates in the drainage water, which is followed by their almost entire disappearance in summer. Autumn shows the maximum amount of nitrates for the year, and winter stands second in the richness of the drainage water. The plat receiving ash constituents shows a little more nitrate in the drainage water than the permanently unmanured land." In the case of plats receiving ammonium salts in March the drainage water was richest in nitrates in the spring and disappeared in June or July, and even as early as May. With nitrate of soda the loss was much less than with ammonium salts. When nitrogenous manures were applied in the fall the greatest loss of nitrates occurred during the winter months.

The deep wells of Harpenden.—"The water supply of Harpenden is derived entirely from wells sunk in the chalk, which comes in some places to the surface, and is probably never more than 25 feet beneath it. The water in the wells is in the valley about 60 feet and on the hills about 120 to 145 feet below the surface. The water level of the district exhibits a rather steep gradient, the underground flow of water being apparently from northwest to southeast. This flow of underground water consists of the mixed drainage of a large area of agricultural land."

A study of the incontaminated wells of this district showed them to contain a constant but comparatively large proportion of chlorine (10.7 to 11.3 parts per million). The proportion of nitrogen as nitrates in these waters varies from 4.4 to 5.2 parts per million during the year and averages 4.7 parts. Taking the average drainage of the Harpenden district as 8 inches, we have an annual loss of about 8 pounds of nitric nitrogen per acre. Turning now to the contaminated wells we find the chlorine ranges "from 11 (the standard of purity) to 173, the nitric nitrogen from 5 to 44 parts per million of water." This variation is a ready means of detecting contaminated wells. It is determined largely, however, by the rainfall. "When once the soil has become saturated the effect of any heavy rain is sure to appear in the well waters, but usually about 1 month after the rain has occurred." The proportion of chlorine to nitrogen varies greatly, but in individual pure wells, the proportion is much more constant than is the case with contaminated wells. Tabulated data for the mineral constituents of water from contaminated and incontaminated wells are discussed as follows:

There is a much larger quantity of dissolved matter in the polluted than in the pure waters. The proportion of silica shows no rise with pollution; the proportion of carbonates shows a very small rise. On the other hand the amount of lime, and still more of magnesia, present in the waters receiving sewage contamination, is much increased. * * *

The great rise in the proportion of sulphates is, however, a fact which we have not yet noticed; it is greatest in the nitric well, a circumstance which certainly suggests the thought that both nitrates and sulphates are originally derived from the albuminoids of food. It would appear that the quantity of alkalis in the contaminated waters was three or four times as great as in the incontaminated; the alkali present was probably soda. The undetermined matter will consist in part of alkalis; these were undoubtedly present, as the total acids were in all cases in excess of the lime and magnesia determined.

The quantity of sulphuric acid in the pure well water appeared so remarkably small that a second determination was made later in the year, using two liters of water for the experiment; the amount of sulphuric anhydride obtained was, however, only 2.75 per million. This amount is scarcely more than that found on an average in the Rothamsted rain, namely, 2.52 per million.

DIVISION OF STATISTICS.

REPORT NO. 95 (NEW SERIES), MAY, 1892 (pp. 151-196).—This includes articles on the condition of winter grain; progress of cotton planting; changes in cultivated area; a wool retrospect; the French tariff; reciprocity treaties with Salvador, Germany, Nicaragua, and Honduras; European crop report; and transportation rates.

Number, average price, and value of sheep, and the number of pounds of wool grown in the United States during the years 1871 to 1892.

Year.	Number.	Average price.	Value.	Pounds of wool.
1871	31,851,000	$2.33	$74,035,837	153,000,000
1872	31,679,300	2.80	88,771,197	150,000,000
1873	33,002,400	2.96	97,922,350	158,000,000
1874	33,938,200	2.61	88,690,569	170,000,000
1875	33,783,600	2.79	94,320,652	181,000,000
1876	35,935,300	2.61	93,666,318	192,000,000
1877	35,804,200	2.26	80,892,683	200,000,000
1878	35,740,500	2.26	80,603,062	208,250,000
1879	38,123,800	2.07	79,023,984	211,000,000
1880	40,765,900	2.21	90,230,537	232,500,000
1881	43,569,899	2.39	104,070,861	240,000,000
1882	45,016,224	2.37	106,595,954	272,000,000
1883	49,237,291	2.53	124,365,835	290,000,000
1884	50,626,626	2.37	119,902,706	300,000,000
1885	50,360,243	2.14	107,960,650	308,000,000
1886	48,322,331	1.91	92,443,867	302,000,000
1887	44,759,314	2.01	89,872,839	285,000,000
1888	43,544,755	2.05	89,279,926	269,000,000
1889	42,599,079	2.13	90,640,369	265,000,000
1890	44,336,072	2.27	100,659,761	276,000,000
1891	43,431,136	2.50	108,397,447	285,000,000
1892	44,938,365	2.58	116,121,270	....

"It appears that the domestic supply of wool is six times as great as in 1840, and that both domestic and foreign supplies were only 3 pounds to each inhabitant, while they are now 6.5 pounds. Then, including imports of woolens, scarcely 4 pounds per head was used, whereas we now require over 8 pounds. * * * Three fifths of all the wool used for all purposes is of domestic production, while four fifths of the requirement is manufactured in this country, leaving only one fifth to come in the shape of imported goods."

MISCELLANEOUS REPORT NO. 2.

AGRICULTURE OF SOUTH AMERICA, A. BARNES (pp. 189, plates 3).—A series of articles on the agriculture and commerce of the different countries of South America, most of which have been published in the monthly reports of the Division of Statistics. During the fiscal year ending June 30, 1891, the aggregate of the trade of the South American countries with the United States was—

$151,963,069, made up of exports valued at $33,226,401, and imports valued at $118,736,668. It will be seen that the imports constitute 78 per cent of the whole. The agricultural imports represent the value of $100,889,912, of which 92 per cent were received absolutely without a tariff charge. The agricultural exports amount to $12,242,439. * * *

The great disparity in amount and value of these exchanges, as shown in this bulletin, is due in part to want of direct shipping facilities, such as are enjoyed by other nations that practically monopolize the trade. While this trade has heretofore been so unequal, it has been so much a necessity as to require $8 in agricultural imports for every dollar of agricultural exports, under the famine of transportation facilities which has heretofore existed. Seventy per cent of this agricultural importation, or $70,675,787, came from Brazil, of which $62,022,022 was for coffee.

Miscellaneous Report No. 3.

Coöperative credit associations in certain European countries, E. T. Peters (pp. 117).—This includes accounts of the German credit unions or people's banks, Raiffeisen loan associations, German legislation on coöperative associations, people's banks of Austria-Hungary, and coöperative banking in Italy and Russia.

The following comparative statements show the greatness of the interests involved in these associations, as well as their intimate connection with the welfare of the agricultural classes:

The latest date for which returns are at hand for all the countries is the close of the year 1887. At that time Germany had 2,135 of the Schulze-Delitzsch credit unions, and probably about 800 of the Raiffeisen associations. The people's banks of Austria numbered 1,313, of which 118 were unregistered. The totals in Hungary and Italy, respectively, appear to be identical with the numbers making returns, at least there is no indication to the contrary. The total number in Russia at the same date was somewhat above 900. Of the Schulze-Delitzsch unions the number which made returns for the date named was only 886, or about 41 per cent of the whole number. For Austria the number making returns as to their capital and business is estimated at 75 per cent, and 75 per cent of the 1,195 registered banks would be 986, while the numbers for Hungary, Italy, and Russia are, respectively, 488, 641, and 712. This gives a total of 3,623 that made returns for the close of 1887, exclusive of associations of the Raiffeisen and Wollemborg types.

The number of members actually returned is highest in Austria, but that is understood to include the membership of all the registered associations, and if allowance were made for the large number of the German Schulze-Delitzsch unions which did not make returns, their membership would be very much larger than that of the Austrian institutions. For Hungary no figures as to the number of members have been found. The actual figures furnished for the German societies are 456,276; for the Austrian, 513,756; for the Italian, 318,979; and for the Russian, 193,945, making a total of 1,482,956. A very moderate estimate for Hungary, for the unregistered societies of Austria, and for the German and Russian societies not making returns as to their membership—including among the former the Raiffeisen loan associations—would raise the aggregate membership to at least 2,250,000, and an estimate of 2,500,000 would scarcely be extravagant.

We have seen that in the German credit unions making returns, about one third of the members, if we include gardeners and rural laborers, belong to the agricultural class. The proportion of agriculturists in those not making returns is probably higher, since these will naturally consist to a greater extent than the others of unions located in the smaller towns surrounded by agricultural populations; while the membership of the Raiffeisen associations is mainly agricultural, as also is that of the Russian associations; and in the Italian popular banks the rural class appears to be more largely represented than in the Schulze-Delitzsch credit unions. In view of these considerations, it is evident that considerably more than one third of the members estimated to be embraced in all the associations must consist of farmers, gardeners, and others earning their livelihood by the cultivation of the soil. The number of this class of members can in fact hardly be less than 850,000, and it may not fall far short of 1,000,000.

It will be remembered that the date to which these figures refer is December 31, 1887. The paid-in capital and reserve funds, with the deposits and other borrowed capital of the institutions making returns for the same date, are given below:

Countries.	Paid-in capital.	Reserve fund.	Capital, including reserve.	Deposits and other borrowed funds.	Total capital employed.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Germany	26,330,226	5,770,262	32,100,488	101,655,893	133,756,381
Austria	9,815,250	3,822,600	13,637,850	77,310,360	90,948,210
Hungary	8,737,712	512,325	9,250,037	6,640,802	15,890,839
Italy	15,875,436	4,218,594	20,094,030	82,551,285	102,645,315
Russia	2,488,459	453,569	2,942,028	3,522,433	6,464,461
Total	63,247,083	14,777,350	78,024,433	271,680,773	349,705,206

In round numbers the total capital employed may be set down at $350,000,000.

It will be kept in mind that these amounts are exclusive of those of associations not reporting, which comprise about 59 per cent of the Schulze-Delitzsch credit unions of Germany, 25 per cent (as estimated) of the people's banks of Austria, and probably about 200 of the rural coöperative banks of Russia, while they are also exclusive of all the figures for the Raiffeisen associations, which are too scattered and fragmentary to justify an attempt to estimate their amount.* If we consider only the associations making returns, Italy, in proportion to her population, outranks any one of the other nations in respect to the amount of capital employed by her popular banks. Russia, on the other hand, while standing quite high in the number of banks reporting, exhibits an amount of capital which, as compared with that of the German, Austrian, or Italian popular banks, is utterly insignificant.

Miscellaneous Report No. 4.

Wages of farm labor in the United States (pp. 69).—Notes and tabulated data on investigations of wages at nine different times during a period of 26 years (1866–92), on the supply of labor in the different States and localities, and on wages in earlier years.

The investigations of rates of wages for farm labor, nine of which have been made during the past 26 years, have been very complete in method and satisfactory in result. Beginning when labor was in demand to repair the wastes of war, the average rates were high, gradually declining, finding lowest level in 1879, then rising to a normal status, which has been maintained with wonderful uniformity during the last 10 years.

Wages, without board, per month.

Sections.	1892.	1890.	1888.	1885.	1882.	1879.	1875.	1869.	1866.
Eastern States	$26.46	$26.64	$26.03	$25.30	$26.55	$21.36	$29.00	$32.03	$33.31
Middle States	23.83	23.62	23.11	23.19	23.21	20.24	26.99	29.19	29.83
Southern States	14.86	14.77	14.54	14.27	14.67	12.65	15.28	16.49	16.63
Western States	22.61	22.01	22.23	22.27	23.26	19.81	23.25	26.39	27.84
Mountain States	32.16	31.94	33.37	30.24	36.50	....	....	....	27.23
Pacific States	36.15	34.87	36.73	37.78	37.22	40.11	43.50	46.38	44.60
Average	18.60	18.34	18.24	18.06	18.58	16.05	19.49	25.92	26.87

*The Italian associations of the Wollemborg type are also omitted, but of these there were only 18 at the close of 1887.

Wages, with board, per month.

Sections.	1892.	1890.	1888.	1885.	1882.	1879.	1875.	1869.	1866.
Eastern States	$17.50	$17.71	$17.21	$16.70	$16.92	$13.03	$18.59	$20.44	$20.82
Middle States	15.78	15.61	15.41	15.24	14.71	12.37	16.98	18.37	19.01
Southern States	10.02	10.10	9.90	9.90	9.92	8.46	9.94	10.55	10.75
Western States	15.36	15.00	15.09	15.20	15.60	12.75	15.44	17.04	18.48
Mountain States	21.28	20.64	21.99	19.74	27.08	....	....	....	17.61
Pacific States	24.25	22.50	25.08	24.37	23.73	25.88	28.13	28.69	29.48
Average	12.54	12.45	12.36	12.34	12.41	10.43	12.72	16.55	17.45

While farmers have suffered from low prices of certain products, they have been unable to reduce the rates of wages. It might be supposed that the depression in agriculture, of which so much has been said and written, would be attended with a decline in the rate of compensation paid for labor. This has not taken place. The demand is well sustained. Wages have not declined. Many a farmer complains that labor costs too much, that values of products do not warrant the rates demanded, and yet he must have it, and promptly makes the engagement. It is the compulsion of competition, an indication of general employment and a fair degree of prosperity.

The returns give a true explanation of the apparent anomaly of low prices and high wages. There is a difference in employers. Some are progressive, increase the fertility of their lands, use the best methods and implements, employ labor, pay good wages, and make money; others are less enterprising, diligent, or progressive, and make small net profit or none at all. As margins of profit grow narrow, skill is at a premium, wastes are ruinous, the skillful succeed, the careless go to the wall. The returns are full of indications that the present is a crucial test of the individual farmer. They teach the necessity of progress in agriculture, and especially a facility for prompt adaptation of current effort to changing conditions.

A careful analysis of all the data collected concerning farm wages from 1840 to 1865, in comparison with results of the more recent investigations, will show that in 50 years the compensation of farm labor has very nearly doubled. * * *

In comparison with other countries, American farm labor stands first in rate of compensation. The present rate of $282 per annum for labor of the Caucasian race can scarcely be approached by any country, unless by Australia. An average of other countries can not be authoritatively stated, but current estimates have been frequently quoted about as follows: Great Britain $150, France $125, Holland $100, Germany $90, Russia $60, Italy $50, and India $30. The present rate can only be maintained by keeping up the fertility of the soil, utilizing the best results of invention and skill in implements and machinery, advancing the status of practical agriculture, supplying all domestic demands for all required products, and seeking foreign markets for the surplus.

DIVISION OF ENTOMOLOGY.

BULLETIN NO. 27.

DAMAGE BY DESTRUCTIVE LOCUSTS IN 1891, L. BRUNER, D. W. COQUILLETT AND H. OSBORN (pp. 64).—Reports of investigations by three field agents, carried on in view of the fact that locusts were reported to be unusually numerous in the Western States. Notes are given on *Dissosteira longipennis*, *D. spurcata*, *Caloptenus* (*Melanoplus*) *spretus*, *C. atlantis*, *C. bivitatus*, *C. femur-rubrum*, *C. devastator*, *C. differentialis*, *Camnula pellucida*, *Pezotettix enigma*, *Trimerotropis pseudofasciata*, and *Œdipoda venusta*, with statements regarding natural enemies and means of repression. Professor Osborn's report was previously

published in Insect Life, vol. IV, p. 49. As the general result of the investigations it appeared that while "a number of species of local non-migratory locusts had multiplied far beyond the normal point and had undoubtedly done more or less damage, and while swarms and isolated individuals of the true Rocky Mountain locust had appeared in a few cases, the reports as a whole had been greatly exaggerated."

DIVISION OF FORESTRY.

BULLETIN NO. 6.

TIMBER PHYSICS, PART I, B. E. FERNOW (pp. 62, plates 6, figs. 11).—A notice of the introductory portion of this bulletin and an account of the organization and methods of the investigation in progress in the Division of Forestry was given in Experiment Station Record, vol. III, p. 729. The remaining portions of the bulletin contain articles on the scope and historical development of the science of timber physics, including references to both European and American work; the organization and methods of the timber examinations in the Division of Forestry; work at the test laboratory at St. Louis, Missouri, by J. B. Johnson; examination into the physical properties of test material, by E. Roth; instructions for the collection of test pieces of pines for examination; forms for records; and illustrative records of tests. Among the illustrations are plans of the testing laboratory at St. Louis and of the testing machines.

The subject matter comprised in Timber Physics is classified as follows:

I.—WOOD STRUCTURE OR XYLOTOMY.

(*a*) *Exterior form.*

Here would be described the form development of timber in the standing tree, differentiated into root system, root collar, bole or trunk crown, branches, twigs; relative amounts of material furnished by each.

(*b*) *Interior structural appearance;* differentiation and arrangement of groups of structural elements.

Here would be described the gross structural features of the wood, the distribution and size of medullary rays, vessels, fibro-vascular bundles, as exhibited to the naked eye or under the magnifying glass on tangential, radial, and transverse sections; the appearance of the annual rings, their size, regularity, differentiation into summer and spring wood, and all distinguishing features due to the arrangement and proportion of the tissues composing the wood.

(*c*) *Minute anatomy or histology:* differentiation and arrangement of structural elements.

Here the revelations of the microscope are recorded, especially the form, dimensions, and structure of the different kinds of cells, their arrangement, proportion, and relative importance in the resulting tissues.

(*d*) *Comparative classification of woods*, according to *structural* features.

(*e*) *Laws of wood growth* with reference to structural results.

Discussion of the factors that influence the formation of wood in the standing tree.

(*f*) *Abnormal formations.*

Burls, bird's-eye, curly, wavy, and other structural abnormities and their causes.

II.—PHYSICAL PROPERTIES, *i. e.* properties based on molecular (physical) constitution.

(*a*) *Exterior appearance.*

Such properties as can be observed through the unaided senses, as color, gloss, grain, texture, smell, resonance.

(*b*) *Material condition.*

Such properties or changes as are determined by measurements, as density or weight, water contents and their distribution, volume and its changes by shrinkage and swelling.

(*c*) *Classification of woods* according to *physico-technical* properties, *i. e.* such physical properties as determine their application in the arts.

III.—CHEMICAL PROPERTIES, *i. e.* properties based on atomic (chemical) constitution.

(*a*) *General chemical analysis of wood* (qualitative and quantitative).

Here would be discussed the chemical constitution of different woods and different parts of trees and its changes due to physiological processes, age, conditions of growth, etc.

(*b*) *Carbohydrates of the wood.*

Here would be more specially discussed cellulose and lignin, cork formations, organic contents and their changes, and such properties as predicate the fuel value of wood, its manufacture into charcoal, its food value, pulping qualities, etc.

(*c*) *Extractive materials.*

A knowledge of these underlies the application of wood in the manufacture of tan extracts, resin, and turpentine, tar, gas, alcohol, acids, vanillin, etc.

(*d*) *Antiseptic materials.*

A knowledge of those chemical properties which predicate durability and underlie processes of increasing the same.

(*e*) *Mineral constituents.*

A knowledge of these in particular will establish the relation of wood growth to mineral constituents of the soil and also serve as basis for certain technical uses (potash).

IV.—MECHANICAL PROPERTIES, *i. e.* properties based on elastic conditions exhibited by the aggregate mass under influence of exterior (mechanical) forces.

(*a*) *Form changes without destruction of cohesion*, commonly called elasticity, flexibility, toughness.

(*b*) *Form changes with destruction of cohesion*, commonly called strength (tensile, compressive, torsional, shearing), cleavability, hardness.

V.—TECHNICAL PROPERTIES, *i. e.* properties in combination.

Here would be considered the woods with reference to their technical use, their application in the arts, which is invariably based upon a combination of several physical or mechanical properties.

VI.—DISEASES AND FAULTS.

Here would be treated the changes in structure and properties from the normal to abnormal conditions, due to influences acting upon the tree during its life or upon the timber during its use.

VII.—RELATION OF PROPERTIES TO EACH OTHER.

Here would be discussed the connection which may be established between structure, physical, chemical, and mechanical properties, and also between these and the conditions of growth under which the material was produced. The philosophy of the entire preceding knowledge would here be brought together.

ABSTRACTS OF REPORTS OF FOREIGN INVESTIGATIONS.

On the determination of crude fiber, S. Gabriel (*Zeitsch. f. physiol. Chem., 16, pp. 370–386*).—The author made a critical study of Hönig's method for cellulose determination, which depends on converting the albuminoids and starch into soluble compounds by heating with glycerin at 210° C. This method in its original form was found to be unreliable for the analysis of vegetable products. Neither all of the protein nor of the nitrogen-free substances were converted into soluble compounds, over 1.5 per cent of nitrogen remaining in the crude cellulose. He then set about eliminating the errors of the method by modifications. It was found that when 2 grams of potassium hydrate was dissolved in 60 c. c. of glycerin and this mixture was heated with 2 grams of yellow lupine seed at 180° C. the results very nearly approached those by the Weende method, and the nitrogen remaining in the crude cellulose was reduced to a minimum (0.08 to 0.1 per cent). But when this method was applied to hay, sheep dung, barley straw, oats, beets, potatoes, and beech wood the results agreed with those of the Weende method in some cases, and in others were as much as 4 per cent higher. In the case of every substance, however, the nitrogen in the cellulose was very low—lower than with the Weende method.

Crude cellulose prepared by the two methods was tested for noncellulose, nitrogen-free substances, by means of hydrolysis and Fehling's solution. That prepared by both methods was found to contain these substances, often in considerable quantities; and special tests indicated that the reduction of copper was not due to hydrolysis of the cellulose, as the acid used was without effect upon it. But as these nitrogen-free substances were so easily inverted and rendered soluble by acid which had no effect upon the cellulose itself, the method was modified to include this digestion with acid. Triplicate determinations were then made of the cellulose in yellow lupine seed, hay, sheep dung, barley straw, oats, beets, and beech wood, digesting with glycerin-alkali solution first, and afterwards with 0.6 per cent hydrochloric acid to remove any nitrogen-free substances other than cellulose remaining. The averages of these determinations as compared with those by the Weende method were, in terms of nitrogen-free and ash-free cellulose, as follows:

Results of crude fiber determinations.

	Glycerin-alkali method.	Weende method.
	Per cent.	*Per cent.*
Lupine seed	16.49	16.63
Hay	21.11	26.28
Sheep dung	24.69	28.69
Barley straw	40.06	39.51
Oats	11.22	10.92
Beets	4.83	4.96
Beech	56.50	60.39

In general the agreement between parallel determinations was closer by the glycerin-alkali than by the Weende method. The former method is believed to more completely exclude the non-cellulose, nitrogen-free substances from the final product than the Weende method. Swedish filter paper, containing 6.62 per cent water, 0.38 per cent ash, and (by difference) 93 per cent cellulose, was tested by the glycerin-alkali method, which indicated 84.37 per cent of cellulose, a loss of 8.63 per cent of cellulose, which is supposed to have been dissolved by the reagents, but which is within the minimum limit of loss (8.9 per cent) observed by Kern with the Weende method.

The description of the working method, as finally modified by the author, is given as follows:

Two grams of finely ground substance are digested at 180° C. with 60 c. c. glycerin-alkali solution (33 grams KOH in 1 liter glycerin), in a 250 c. c. flask, heating on wire gauze. A lively reaction, accompanied by frothing, takes place at 130° to 140°. At frequent intervals the flask is given a gyratory motion to wash down the substance. At 160° the principal reaction is over, but the temperature is gradually raised to 180°. After cooling to 140° the contents of the flask are poured into a dish containing 200 c. c. of boiling water, thoroughly stirred, allowed to settle, and the supernatant liquid siphoned off with a siphon similar to that commonly used in the Weende method. The residue is washed twice more in this way with 200 c. c. of water, allowing the water to come to a boil each time, and the last time adding 5 c. c. of 25 per cent hydrochloric acid. The residue is then, as by the Weende method, washed with alcohol and with ether, dried and weighed, and the ash is determined. In many cases the determination of the nitrogen in the product may be omitted as this is so small by this method as to be without appreciable effect on the final result.

The modified method is believed to compare favorably with the Weende method in every respect, and in point of rapidity to have the advantage. Three hours are said to be sufficient for making three determinations from weighing out to final washing.

Pentaglucoses, their occurrence in plants and their analytical determination, B. Tollens, A. Günther, and G. de Chalmot, reported by B. Tollens (*Jour. f. Landw., 40, pp. 11–17*).—For some time the author has been engaged in studying the constituents of the so-called

nitrogen-free extract of feeding stuffs, as well as the substances associated with cellulose in wood and in the lignified parts of plants, believing a correct determination of the feeding value of the nitrogen-free extract of feeding stuffs to be possible only after thorough investigation of the individual components of the nitrogen-free extract and of so-called crude fiber. Since his own investigations and the investigations of others have shown the almost universal occurrence of pentaglucoses in vegetable products, the elaboration of a method for the quantitative determination of these substances was believed to be of importance. The nitrogen-free extract and the crude fiber as determined by the ordinary methods of fodder analysis include pentaglucoses, often in considerable quantities. Pentaglucoses differ from the true carbohydrates by yielding furfurol instead of levulinic acid when treated with hydrochloric acid of a certain concentration, and in certain color reactions. The qualitative determination of the pentaglucoses in vegetable matters is made by heating the substance for a few minutes with dilute hydrochloric acid in a water bath, whereby the carbohydrates and also the pentaglucoses and substances which yield these are dissolved. If the filtered extract is now heated with strong hydrochloric acid and phloroglucin a cherry-red color is produced if arabinose or xylose are present, while the true sugars only give a brownish color. This reaction is further characterized by dark lines in the spectrum. The pentaglucoses are determined quantitatively by distilling vegetable substances containing them with hydrochloric acid of certain concentration and determining the furfurol in the distillate. The author has given much time to the perfection of this method (see Experiment Station Record, vol. II, p. 685). The reaction is given as follows: Furfurol, $C_5H_4O_2$, is derived from arabinose or xylose, $C_5H_{10}O_5$ by the splitting off of three molecules of water. The substance is volatile, and when freed by hydrochloric acid appears in the distillate. The formation of furfurol from these substances is a quantitative one. The furfurol in the distillate is determined quantitatively by means of phenylhydrazin, $C_6H_8N_2$, a reagent for aldehydes and ketones in general. With this it forms a nearly insoluble compound, furfurol-hydrazon. The hydrazon separates out when an aqueous solution of phenylhydrazin and acetic acid is added to the distillate. The hydrazon can be filtered and weighed and the furfurol calculated from the weight; or the furfurol may be estimated by means of titration, determining the amount of phenylhydrazin of known strength which is required to precipitate all the furfurol in the distillate. Both methods have been worked out by the author, the titration method in company with A. Günther, and the gravimetric method with de Chalmot.* From the percentage of furfurol which is found in the distillate the calculation of the amount of arabinose or xylose yielded by the substance may be made by use

* A method for the quantitative estimation of the pentaglucoses has also been published by W. E. Stone in *Jour. Anal. and Appld. Chem.*, *5*, *No. 8*.

of the proper factors. These factors have been worked out by distilling chemically pure arabinose and xylose with hydrochloric acid and determining the amount of furfurol yielded. Roughly speaking, these pentaglucoses yield nearly half of their weight in furfurol. A large number of determinations of the pentaglucoses in different agricultural products have been made under the author's direction. The results of some of these determinations are given in the following table and are compared with the average percentage of nitrogen-free extract in these materials, the figures for which are taken from Mentzel and v. Lengerke's *Landw. Kalender* for 1891.

Pentaglucoses and nitrogen-free extract in feeding stuffs, etc.

	Pentaglucoses.	Nitrogen-free extract.
	Per cent.	*Per cent.*
Rye straw	25.2	33.3
Wheat straw	25.8, 27.7	36.9
Barley straw	25.6	36.7
Oat straw	25.8, 26.1	36.2
Pea vines	16.9	34.0
Meadow hay	18.3	41.4
Clover hay, first period	9.2	35.0–38.0
Clover hay, second period	10.6	
Beech wood	23.8, 19.7	....
Spruce wood	13.2, 7.9	....
Brewers' grains	22.4	43.6
Wheat bran	24.7	55.6
Sugar beet diffusion residues	33.4	54.8
Beet pulp	24.9	....
Crude fiber from oat straw	13.9	....

It will be seen that in many cases, as in the straw of cereals, the pentaglucoses amount to more than half of the nitrogen-free extract, while in the case of pea vines, meadow hay, clover hay, diffusion chips, and wood considerable amounts are present. The crude fiber of oat straw as determined by the Weende method is shown to contain a considerable amount of pentaglucoses. The results indicate how important a factor this class of bodies may be in fixing the nutritive value of the nitrogen-free extract, provided they are found to possess a higher or a lower nutritive effect than starch or sugar.*

It has been claimed by some chemists that furfurol occurs in the decomposition products of albuminoid bodies, and it was suggested that by digesting albumen or casein with acid, pentaglucoses might be formed. To test this matter experiments were made with casein and with horse meat, both of which were carefully freed of all carbohydrates, which showed that only mere traces of furfurol were formed. The conclusion is, therefore, that albuminoid bodies yield only traces of furfurol. Glycuronic acid, however, numerous derivatives of which occur in the urine of men and animals after consuming certain substances, was found to yield similar amounts of furfurol to arabinose and xylose.

* Stone found the pentaglucoses to be less digestible for rabbits than the other carbohydrates (*Am. Chem. Jour., 14, No. 1*).

The author's investigations on this subject are to be continued· It is hoped to further perfect the method of furfurol determination, and to get light on the form and composition of the mother substance of arabinose and xylose in plants.

The occurrence of guanidin in plants, E. Schulze (*Ber. d. deut. chem. Ges.*, *25* (*1892*), *p. 658*).—According to the investigations of the author, guanidin occurs in etiolated vetch plantlets. Vetch plantlets which had grown for 3 weeks in the dark were dried, ground, and extracted with warm 92 per cent alcohol. The alcohol was distilled off, the residue treated with water, tannic acid added to the cloudy solution, and then acetate of lead. The material was then filtered, the lead removed with sulphuric acid, and phospho-tungstic acid solution added, which gave a heavy precipitate. This was filtered off, washed with dilute sulphuric acid, dried between filter paper, and then treated with cold milk of lime. The filtered alkaline solution was then treated with carbonic acid, filtered, neutralized as nearly as possible with nitric acid and then evaporated by gentle heat to a thin sirup. Out of this crystals separated after standing some time, which were dissolved in hot 95 per cent alcohol, and which were recovered by evaporation of the alcohol and recrystallization from an aqueous solution. The product was found to be nitrate of guanidin. The yield was very small, only 1 gram of guanidin nitrate being secured from 3 kg. of dried vetch plantlets. No guanidin could be found in seeds of vetch which had not sprouted.

Concerning tubercles on the roots of leguminous plants, J. Lachmann (*Centralbl. f. agr. Chem.*, *20*, *pp. 837–851*).—Attention has been called to a paper on the above subject published by the author in 1858 in *Landw. Mitteilungen, Zeitsch. der königl. höheren landw. Lehranstalt, etc., zu Poppelsdorf.* The article seems until recently to have been overlooked, but is reprinted in full at the above citation. The author first observed tubercles on the roots of the white clover. Later he examined a large number of papilionaceous plants and gave a list of between 40 and 50 species bearing root tubercles. He also observed them on *Acacia stricta*, *A. hispidissima*, *A. lophantha*, and *A. latifolia*. In the case of different species they occurred on different parts of the root, but were in every case situated on the true root, and were not regarded as modified branches of the rhizome. They differed as to the depth at which they were located beneath the surface, being in some instances near the surface and in others several feet below it. The form, size, and number of the tubercles are minutely described. Trials were made of growing yellow lupine in boxes filled with different kinds of soil, from light sandy to heavy clayey loam. The results of these trials indicate the sandy and sandy loam soils to be far better adapted to the growth of yellow lupine and to the formation of root tubercles than heavier soils or those containing considerable lime. Plants grew vigorously in rich, peaty, and humus soils, but produced no tubercles.

Although the number, position, size, form, etc., varied in the case of different species of plants, the anatomy of the tubercles was found practically the same for all, and was very different from that of the roots bearing them. The author's description of the structure of the tubercles was briefly as follows: The tubercles consist of an outer layer of bark parenchyma, often containing starch, inclosing an inner tissue of circular cells which increase in size as the center of the tubercle is approached. Between the two kinds of tissue are a number of fibro-vascular bundles, which are branches of those in the root but do not proceed to the end of the tubercle. The central tissue contains a thick, cloudy layer of protoplasm on its inner walls, sometimes completely filling the cells. This cloudiness is attributed to innumerable small, elongated, rod-shaped bodies, usually consisting of two or three small branches, and resembling vibriones. They are stained brownish green by iodine, like protein substances, and exhibit a lively molecular and sometimes a vibrio motion in water.

The tubercles are transitory, seldom lasting through the year, and are continually being formed during the greater part of the life of the plant. They are decomposed by a peculiar process of solution, and at the same time new tubercles are formed on the younger branches of the roots. He believes the tubercles to be of physiological rather than pathological nature. They possess an unusual capacity for absorbing liquids, but he doubts whether their function consists exclusively in furnishing the plant with water. Regarding their true function he seems to be somewhat in doubt. He refers to the general belief among farmers that certain leafy plants, notably papilionaceous plants, are able to assimilate the free nitrogen of the atmosphere. He intimates that these root tubercles may have a connection with this supposed ability. He suggests that by their means leguminous plants may be able to use to better advantage and more completely than other plants the nitrogen applied to the soil in the form of ammonium salts or nitrates, in that the tubercles act as reservoirs for collecting and storing nitrogenous materials which later can be given up to the plant as it requires. The supply of ammonium salts and nitrates in the soil may be cut off from the reach of plants with short roots by being washed into the lower layers of the soil by rains. In that case the papilionaceous plants can fall back upon the reserve protein substances stored up in the tubercles and thus continue their growth. If the papilionaceous plants do enrich the soil with nitrogen, as agriculturists claim, then this, he says, is probably due to the richness of their roots, and particularly the tubercles, in nitrogenous compounds. The latter are in a sense reservoirs storing up plant food, especially nitrogen, at favorable times when an excess is available, and preventing it from being washed away from the reach of the roots. Later their supply of plant food is given up to the plant or the soil.

A note by the editor at the conclusion of the above article states that Dr. Körnicke has traced the observation of tubercles on the roots of leguminous plants back to 1587, when Dalechamps in *Historia generalis plantarum*, described *Ornithopus perpusillus* under the name of *Ornithopodium tuberosum*, giving an illustration of the tubercles. The description and illustration of the tubercles are said to leave no doubt as to their identity.

On the presence of an aërobic ferment in straw, which reduces nitrates, E. Breal (*Compt. rend., 114* (*1892*), *pp. 681–684*).—Schlösing and Müntz have stated that the nitric ferment is present in all arable soils. The author announces the existence of another ferment, likewise aërobic, but possessing the property of reducing nitrates.

This organism is found in straw and is probably present in all vegetable refuse. If straw be carefully tested by means of the diphenylamine reaction, traces of nitrate will in almost every case be found on the surface, but if the straw is allowed to remain a few days in water no nitric acid is found, although this reagent permits of the detection of 1 gram in 10,000,000.* If increasing quantities of nitrate be added to the water extract of the straw a rapid disappearance of the nitric acid is observed.

This reduction of nitric acid is due to a ferment, for if the moist straw be sterilized by heat or by an antiseptic, as for example bichloride of mercury, the nitrates no longer disappear. For purposes of observing the closeness with which the ferment adheres to the straw, a small quantity of the latter was placed in 800 c. c. of water containing 0.1 gram of nitrate of potash; next morning no nitrate was present. The liquid was then divided into two equal parts between two different vessels, and each received 0.1 gram of nitrate of potash, but in only one was the straw soaked. After 24 hours the solution containing the straw contained no nitric acid; the other had not denitrified after 5 days.

For detecting the presence of nitric acid in a solution, a drop was transferred to a small glass plate previously moistened with a dilute solution of hydrochloric acid, and dried on a warm plate away from the flame. After cooling, a drop of the reagent was added to the traces of the drop of the solution. If nitrate was present a blue coloration was produced. In the case of solid bodies an extract with distilled water was made and the solution tested in the same manner.

Experiments by the author showed that this ferment does not reduce the nitrates to ammonia, as is the case in putrescent fermentation, nor to the lower oxides which Dehérain and Marquenne have found to be formed in vegetable mold by an aërobic ferment, but that free nitrogen is the product of the reduction.

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* The sulphate of diphenylamine was prepared as follows: Boil pure sulphuric acid to drive out traces of nitric acid which it may contain. After cooling dissolve in 100 grams of the acid 1 gram of diphenylamine which has previously been washed and dried, and add 25 c. c. of distilled water.

That the ferment is aërobic is indicated by the fact that reduction goes on more rapidly in flasks supplied with oxygen.

The ferment reduces the nitrates of the soil. If when the soil is drying and the nitrates rising to the surface it is covered with wet straw which is allowed to dry out slowly, nitrates are not found either in the surface soil or in the straw.

While a part of the nitrogen of the nitrates is set free a certain portion is combined with organic substances. In one experiment a third of the nitric nitrogen was lost, while the straw and the water in which it was soaked tripled its organic nitrogen. In a second experiment 67 per cent of the nitric nitrogen was lost.

To observe the evolution of nitrogen two series of experiments were carried out. In one series the moist straw was placed in test tubes (*eprouvettes*), which were filled with 1 per cent nitrate of potash solutions and inverted in the same solution. The second series was carried out in the same manner, substituting pure water for the nitrate of potash solution. Into each test tube there was introduced 24.5 c. c. of air containing 19.6 c. c. of nitrogen. The gas obtained was analyzed with the following results:

Reduction of nitrates to free nitrogen by the aërobic ferment.

	Total volume of gas.	After treatment with—		Nitrogen evolved.
		Potash.	Pyrogallol.	
With nitrate of potash:	*c. c.*	*c. c.*	*c. c.*	*c. c.*
No. 1	26.5	25.0	21.6	2.0
No. 2	34.0	30.3	30.3	10.7
No. 3	27.5	26.3	25.1	5.5
No. 4	31.3	27.0	27.0	7.4
With pure water:				
No. 1	23.5	23.0	19.7	....
No. 2	21.2	20.8	19.7	....
No. 3	20.5	20.0	19.6	....
No. 4	19.5	19.5	19.5	....

No nitrogen was evolved in the tubes containing pure water, and it should be explained that in Nos. 1 and 3 of the first series the oxygen of the air introduced was not completely exhausted, a further evidence that the ferment is aërobic.

It is believed that the reduction of nitrates in arable soils by this ferment need not be feared, because such soils retain only a small amount of water and consequently do not present favorable conditions of development. In meadows and forests it is otherwise. The vegetable residues of such soils furnish the ferment in abundance and retain the moisture necessary to its free development. This furnishes a probable explanation of the fact observed by Boussingault more than 40 years ago—that such soils do not contain nitrates.

The comparative effect of sulphate of iron and sulphate of lime on the conservation of nitrogen in bare soils, and on nitrification, P. Pichard (*Ann. de Chim. et de Phys., 25 (1892), pp. 271–287*).—Having observed in earlier experiments the beneficial effect on nitrification

of the sulphates contained in soils, particularly of sulphate of lime,* it was thought to be of interest to study the comparative action in this respect of sulphate of iron and sulphate of lime incorporated in various artificial soils of known composition.† For this purpose artificial soils were prepared as follows: (1) Cotton-seed meal (containing 4.91 per cent of nitrogen) 0.04 kg., and pure siliceous sand 1.96 kg.; (2) cotton-seed meal 0.04 kg., sand 1.76 kg., and clay 0.2 kg.; (3) cotton-seed meal 0.04 kg., sand 1.94 kg., and carbonate of lime 0.02 kg.; (4) sand 1.74 kg., cotton-seed meal 0.04, carbonate of lime 0.02, and clay 0.2. These mixtures were placed in enameled earthenware pots (16 in all), in the bottoms of which had been previously placed fragments of glass, forming a space through which air could circulate, and from which large tubes passed up through the soil and communicated with the air. These tubes served not only for admitting air but also for introducing the water used in moistening the soil. Different pots containing these mixtures received sulphate of iron ($FeSO_4$) at rates of 1, 2, and 3 grams per kg. of soil, and sulphate of lime at the rate of 5 grams per kg. In addition, pots containing mixture No. 4 received, in different cases, lactate of iron at a rate corresponding to 1 gram of sulphate of iron per kg., and ferric oxide at a rate of 2 grams per kg. The pots were inoculated with 10 c. c. of water-extract of nitrifying soil and pure water was added from time to time. The experiments lasted from May 2 to December 12, at which date the contents of the pots were removed and carefully analyzed. Full details regarding gain or loss of the various forms of nitrogen in each of the 16 experiments are tabulated and discussed at length.

In pure sand the addition of 1 gram of sulphate of iron to 1 kg. reduced the loss of nitrogen from 47.65 to 18.36 per cent; at the same time the gain of nitric nitrogen was increased from 1.43 to 10.4 per cent, and of ammoniacal nitrogen from 4.49 to 11.22 per cent. When clay was added to the soil at a rate of 10 grams to 1 kg. of soil the sulphate of iron sensibly reduced the loss of nitrogen, but the gain of nitric nitrogen was increased from 5.1 to 15.92 per cent, and of ammoniacal nitrogen reduced from 16.94 to 12.75 per cent. The addition of carbonate of lime to the same mixture did not sensibly diminish the loss of nitrogen; the gain of nitric nitrogen was diminished from 5.1 to 2.55 per cent, and that of ammoniacal nitrogen was increased from 6.43 to 10.4 per cent.

In the presence of carbonate of lime and clay the sulphate of iron reduced the loss of nitrogen from 31.63 to 23.87 per cent and diminished the production of nitric nitrogen from 18.57 to 6.43 per cent. In the same medium double and triple doses of sulphate of iron reduced the

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* Compt. rend., May 16, 1884, and September 9, 1889.

† Recent experiments on the effect on nitrification, etc., of different proportions of clay and organic nitrogen were reported in *Compt. rend.*, 114 (1892), pp. 81–84 (see Experiment Station Record, vol. III, p. 636).

loss of nitrogen and at the same time caused a gradual diminution of ammoniacal nitrogen (26.73, 20.61, and 19.59 per cent) and a slight increase of nitric nitrogen (6.43, 7.44, and 9.79 per cent).

In a complete soil (sand, clay, and lime) an addition of lactate of iron, equivalent to 1 gram of sulphate per kg. of soil, almost prevented the loss of nitrogen (only 0.2 per cent), increased the production of nitric nitrogen from 7.14 to 22.34 per cent, and diminished that of ammoniacal nitrogen from 18.57 to 3.57 per cent.

The salts of iron in general injuriously affect the ferments which destroy nitrogenous matter, but the organic salts seem to favor nitrification.

In a complete soil the addition of 2 grams of ferric oxide to 1 kg. of soil reduced the losses of nitrogen from 31.63 to 21.43 per cent, increased the production of nitric nitrogen from 7.14 to 19.69 per cent, and reduced that of ammoniacal nitrogen from 18.57 to 10.71 per cent. The oxide of iron does not hinder the decomposition of nitrogenous matter, but modifies the energetic action of carbonate of lime and favors nitrification by fixation of ammonia after the manner of clay, and by its oxidizing properties. The sulphate of lime (5 grams per kg.) was more favorable to nitrification than sulphate of iron. In pure sand it increased the production of nitric nitrogen from 1.43 to 11.43 per cent; in sand and carbonate of lime from 5.1 to 13.67 per cent; in sand and clay from 5.1 to 23.67 per cent; and in sand, clay, and carbonate of lime from 7.14 to 34.48 per cent.

For the conservation of nitrogen sulphate of lime was much more effective than sulphate of iron in clay soils, equally effective in silico-calcareous soils, but on account of its inferior solubility much less effective in soils of pure sand.

The use of sulphate of iron will prove valuable for the fixation of ammonia in rapidly decomposing material, such as fresh manure, urine, liquid manure, and sewage, but in slowly decomposing organic manures, composts, etc., its value is questionable on account of its antiseptic properties.

Sulphate of iron may be employed with favorable results on dry sandy soils deficient in clay, lime, and oxide of iron. On all others gypsum may be applied more advantageously.

The efficacy of plaster used on soils containing clay and carbonate of lime is explained. The effects of this practice are a modifying of the action of carbonate of lime on nitrogenous organic matter, the fixation of ammonia by the clay and gypsum, a reduction of the loss of nitrogen, and regularity of nitrification.

Effect of sulphate of iron in the soil on the yield of different cereals, A. Mayer (*Jour. f. Landw., 40, pp. 19–22*).—These studies were made at the experiment station at Wageningen, Holland, in the summer of 1891. Ten large zinc cylinders were each filled with about 35 pounds of soil, and 5 seeds each of rye, wheat, barley, and oats were sown in

each cylinder. Sulphate of iron in aqueous solution was added to 8 of the cylinders in amounts ranging from 1 to 200 grams. The two others received no iron. Oats was the only crop which responded favorably to the addition of iron sulphate, the other plants being more or less injured. The relative sensitiveness of the cereals to iron sulphate was in the following order: Wheat, rye, barley, oats. Where the iron was injurious its effect was greater on the fruit than on the plant itself. No kernels were formed where 200 grams of sulphate were used, except in the case of oats, where a few were formed. The practical application of the result is in the use of manurial refuse containing sulphate of iron, and in the selection of crops for land which contains iron salts. The results are in the same line as the observations of practice, that oats are better fitted for iron soils than any other cereals or grasses.

The experiments are to be continued another year with other plants.

A new method for determining the fertilizer requirements of soils, A. Helmkampf (*Hannoversche Land-u. Forstw. Ztg., 1891, p. 683; abs. in Centralbl. f. agr. Chem., 20, pp. 826–828*).—The author gives a preliminary report of the experiments made at the suggestion of Professor Liebscher at the Göttingen Agricultural Institute. The object of these was to determine indirectly by means of plant analysis, in a way similar to that attempted by other investigators, a method for estimating the requirements of the soil, which should give more reliable indications of the supply of available plant food in the soil than is given by the present methods of soil analysis.

Seven plats were selected, each of which contained 8 subdivisions. Since 1874 the 8 subplats of each series had received the following fertilizers each year: (1) Potash, (2) nitrogen, (3) phosphoric acid, (4) potash, nitrogen, and phosphoric acid, (5) unfertilized, (6) potash and nitrogen, (7) potash and phosphoric acid, and (8) phosphoric acid and nitrogen. Four of these 7 plats had received the same crops each year (peas, oats, rye, and potatoes, respectively); on the others rotation had been practiced. The yields for several years had left no doubt that the soil was deficient in potash and nitrogen, but contained sufficient phosphoric acid. If it is possible to determine the requirements of a soil by means of plant analysis the examination of the crops grown on the plats mentioned should answer this question. The analysis of the rye grown on plat 5 in 1890, which on account of being lodged had to be mown while still green, showed that the percentage of phosphoric acid was the same in the crop from all the subplats, but that the percentages of potash and nitrogen varied widely. To further follow this matter, summer wheat was sown on plat 5 and on 2 adjoining plats. The crop was harvested when in bloom, since, according to earlier investigations on the course of assimilation of plant food from the soil, assimilation is practically at an end at this stage. The analyses show, as in the previous year, that the percentage of phosphoric acid

was practically the same in the crops from all the subplats, but that the percentage of potash and nitrogen differed widely according to the way in which the plats were manured. The following table shows the results for the crop grown on the eight subdivisions of 1 plat:

Analyses of summer wheat grown with different fertilizers.

Fertilizers applied.	The crop contained, in dry matter—		
	Nitrogen.	Phosphoric acid.	Potash.
	Per cent.	*Per cent.*	*Per cent.*
No. 1, potash	1.84	0.81	3.64
No. 2, nitrogen	2.25	0.82	2.99
No. 3, phosphoric acid	1.85	0.82	3.03
No. 4, potash, nitrogen, and phosphoric acid	1.99	0.91	4.41
No. 5, unfertilized	1.71	0.85	2.84
No. 6, potash and nitrogen	2.09	0.89	4.14
No. 7, potash and phosphoric acid	1.68	0.74	3.24
No. 8, nitrogen and phosphoric acid	1.89	0.82	2.64

The results indicate that the soil contained sufficient phosphoric acid the percentage of this ingredient in the plants showing no increase from the addition of phosphoric acid to the soil. The percentage of nitrogen and potash it will be seen increased with the addition of these materials to the soil.

From the results of this experiment the author concludes that plant analysis in connection with fertilizer experiments furnishes indications whether or not a soil is deficient in one or more of the essential ingredients. If the percentage of an ingredient in the ash of the crop is increased by the addition of this ingredient to the soil, the conclusion is that the supply of this ingredient in the soil in available form is insufficient, and that therefore it should be applied in the fertilizer. If, on the contrary, the percentage is not increased by the addition of this ingredient to the soil the conclusion is that the soil is already relatively rich in this ingredient.

Concerning the details of the method, for instance as to whether the whole or a part of the plant should be analyzed, what stage of growth is best adapted for the purpose, etc., further investigations are to be made. At present the author is inclined to recommend the analysis of the whole plant at the time of blooming. It is hoped by similar experiments on other soils to work out a simple method for determining the fertilizer requirements of soils.

Effect of nitrogenous manures on the structure and nitrogen content of barley, C. Kraus (*Zeitsch. ges. Brauwesens, 1892, p. 105; abs. in Chem. Ztg., 1892, rep. p. 127*).—The same variety of barley was grown on plats which had received various kinds and amounts of nitrogenous fertilizers, but which otherwise were treated uniformly. The protein content of the barley raised ranged from 12.23 to 14.83 per cent. The richer the nitrogenous manuring the higher the percentages

of both protein and fat in the grain; it was more difficult to soften the richer grain by soaking. Regarding the germination of the seed no difference was observed.

Suggestions for field experiments with fertilizers for field beets, P. Wagner (*Deut. landw. Presse, 1892, p. 320*).—In a few introductory remarks the author explains his position on the subject of field experiments. The general opinion that he is opposed to field experiments he pronounces an error. So far from believing them to be useless, he believes they are absolutely essential in promoting our knowledge of the principles of manuring, not for purposes of research, to be sure, but for testing the application in practice of the theories which have been suggested by scientific investigations on a much more limited scale. For this reason he invites critical tests by practical farmers of the theories he has advanced, and he declares that only by the coöperation of the investigator and the farmer can improvement be made in the practice of manuring crops.

In spite of the many experiments made to compare the effects of like quantities of nitrogen in the forms of nitrate of soda and of ammonium sulphate, which have indicated the nitrate to be the more effective, especially in the case of beets and potatoes, and which have led to the general discarding of ammonium salts for potatoes and beets, this superior effect of nitrate of soda has remained unaccounted for.

Recent experiments by the author and Dr. R. Dorsch* have attributed a special value to the soda contained in Chile saltpeter, especially for crops which require large amounts of potash. They found that when calcium nitrate was used in place of sodium nitrate, that is, when the soda was replaced by lime, the effect of the nitrate was very materially lessened, and on the contrary that the action of ammonium salts was greatly increased by the addition of soda as common salt.† This favorable effect of soda is not attributed to any ability to set free large quantities of plant food contained in the soil, as has been suggested, but to its ability to replace a part of the potash required for a maximum crop, that is, for a crop sufficiently large to utilize all the nitrogen supplied.

This action of sodium is held to be of unusual practical importance, as it throws light on many unexplained facts well known in practice. The author therefore suggests a series of field experiments to further study the action of sodium and to determine its importance in farm practice. He invites the coöperation of farmers in making these practical field trials. The plan outlined is as follows: A piece of land as nearly even as practicable, containing about 6 acres, is to be divided into 10 equal plats (one fourth hectare each). There are to be 5 series

*Published in *Forschungen auf dem Gebeit der Düngungslehre: I.—Die Stickstoffdüngung der Kulturpflanzen.* Berlin, Paul Parey.

†Experiments bearing on this question are noted in Experiment Station Record, vol. III, p. 554.

of plats, 2 plats receiving the same treatment in every case. The fertilizers per acre for the 5 series are—

First series	350 pounds superphosphate (with about 16 per cent phosphoric acid).
Second series	350 pounds superphosphate. 260 pounds ammonium sulphate.
Third series	350 pounds superphosphate. 265 pounds ammonium sulphate. 175 pounds muriate of potash.
Fourth series	350 pounds superphosphate. 265 pounds ammonium sulphate. 175 pounds rock salt.
Fifth series	350 pounds superphosphate. 350 pounds nitrate of soda.

While barley, sugar beets, potatoes, or carrots might be used, he suggests the ordinary field beets used for feeding stock, as these require and readily respond to rich manuring and will be likely to show sufficiently large differences in yield between differently manured plats.

It is hoped that the experiments may be undertaken this season.

On the source and nature of the coloring matter in grapes, A. Gautier (*Compt. rend., 114 (1892), pp. 623–629*).—Careful experiments by Müntz* have shown that the removal of leaves just before the ripening of the grapes in a dry season is injurious, the grapes being relatively acid, deficient in sugar, and yielding wine of poor color and quality. The author has obtained similar results in experiments of this kind. The fruit was poorly developed, deficient in color, and yielded more readily to attacks of fungous diseases. The main object of his investigations, however, was to determine the source and nature of the coloring matter of the fruit. It appears that this is elaborated in the leaves and transferred to the berry at time of ripening, for the removal of leaves about the time of maturity was accompanied in every case by a decided etiolation of the berries, and examinations of the leaves revealed the presence in them of the characteristic grape-coloring matter. Analysis showed this coloring matter to be made up principally of three acids having a composition corresponding to the formulas $C_{19}H_{16}O_{10}$, $C_{17}H_{16}O_{10}$ or $C_{26}H_{24}O_{15}$, and $C_{17}H_{18}O_{10}$, for which the author proposes the names α-ampelochroic, β-ampelochroic, and γ-ampelochroic.

* Compt. rend., 114 (1892), pp. 434–437.

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A new and rapid method for the determination of nitrogen in organic bodies, W. F. K. STOCK.—*Analyst, 1892, June, pp. 109–113.*

On the oxidation of glycerin in an acid solution (*Sull'ossidazione della glicerina in soluzione acida*), S. SALVATORI.—*Staz. sper. agric. ital., 21 (1891), pp. 130–140.*

Determination of glycerin in wines and in other fermented liquors (*Determinazione della glicerina nei vini ed altri liquidi fermentati*), S. SALVATORI.—*Staz. sper. agric. ital., 21 (1891), pp. 141–145.*

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On the proportion of water in butter, A. H. ALLEN.—*Analyst, 1892, June, pp. 104–109.*

Investigations on rancidity and conservation of butter (*Ricerche sulla rancidità e conservazione del burro*), C. BESANA.—*Staz. sper. agric. ital., 21 (1891), pp. 456–465.*

On Pennetier's method for the detection of margarine in butter (*Sul metodo Pennetier per la ricerca della margarina nel burro*), A. PIZZI.—*Staz. sper. agric. ital., 22 (1892), pp. 131–137; abs. in Chem. Centralbl., 1892, I, p. 831.*

The refractive indexes of butter, margarine, and animal fats in the Abbé instrument (*Die Anwendung des Refraktometers für Untersuchung von Nahrungsmitteln, etc.*), MARPMANN.—*Pharmazeut. Centralhalle, 33, pp. 209–211; abs. in Chem. Centralbl., 1892, I, p. 830.*

Bacteriological studies on the ripening of Emmenthaler cheese (*Bakteriologische Untersuchungen über den Reifungsprozess des Emmenthalerkäses*), V. FREUDENREICH.—*Landw. Jahrb. der Schweiz, 5; abs. in Milch-Ztg., 1892, No. 22, p. 368.*

On the chemistry of casein and the theory of the curdling action of rennet (*Zur Chemie des Milch-Kaseïns und der Theorie der Labgerinnung*), G. COURANT.—*Pflüger's Arch., 50, Heft 3 and 4; abs. in Fühling's landw. Ztg., 1892, Heft 12, p. 458.*

Annual Report of the experiment station at Darmstadt, Germany (*Bericht über die Thätigkeit der landw. Versuchsstation Darmstadt für das Jahr 1891*), P. WAGNER.—*Zeitsch, f. d. landw. Ver. Hessen, 1892, No. 20, pp. 160–162.*

EXPERIMENT STATION NOTES.

IDAHO STATION.—A station for Idaho has been located at Idaho Falls, and E. P. Henry has been appointed superintendent. Land is being prepared for next year's work. For the present, work will be confined to testing the adaptability of cereals, grasses, and fruits to the soil and climate of this region, and to experimenting in irrigation.

PENNSYLVANIA COLLEGE.—The board of trustees have established two new courses in agriculture, a course of home reading and a winter dairy course.

The course of home reading in agriculture is especially designed for the young or middle-aged farmer, who, from experience, appreciates the need of better training in agricultural science, but whose business interests will not permit his attendance upon any of the lecture courses offered by the college. It is also expected that the boys and girls of the farm will be interested in the class of literature comprised in the course.

The course is divided into three groups of subjects, each group being designed to cover a year of reading, as follows: (1) Soil and crop production, (2) live-stock husbandry, (3) horticulture.

Supplementary groups will be arranged for those particularly interested in some special branches of one or more of the groups.

In addition to offering the latest and most practical works on the subjects named, the college proposes to make an abstract or synopsis of each text-book, to enable the student to more easily understand the subject treated and its relation to the practical operations on the farm. Arrangements are also made for answering by mail, as far as possible, all questions arising in the course of reading; and when a club or reading circle of 20 or more members desires it, a member of the college faculty will visit such club and deliver one or more lectures on topics related to the reading, provided the actual traveling expenses of the lecturer are borne by the club.

The student is permitted to select such group or groups, or such studies within a group as he prefers and to pursue them as rapidly as he chooses. A written examination may be taken upon each subject and due credit therefor given. Upon the satisfactory completion of any two of the groups a suitable certificate or diploma will be granted.

No entrance examination or fee will be required, and the only expense of the course to the student will be the actual cost of the books which may be purchased through the college at a reduced rate.

The winter dairy course is one of a series of courses of twelve weeks which the college proposes to offer, covering in time the subjects of soil and crop production, live-stock husbandry, horticulture, rural economy, etc. These courses are to be much more technical and practical than is possible to make the short courses in agriculture as now arranged.

The dairy course to be offered this winter comprises two subcourses; one for the home dairyman, and one for the creamery man, each occupying six weeks. All necessary equipment will be put in and the practical work in the dairy will be in charge of an expert butter and cheese maker. The course provides for instruction in (1) dairying, (2) dairy breeds and breeding, (3) stock feeding, (4) dairy chemistry, (5) diseases of dairy stock and their treatment.

RHODE ISLAND COLLEGE.—By an act of the State legislature passed May 19, 1892, the name of the Rhode Island State Agricultural School has been changed to Rhode

Island College of Agriculture and Mechanic Arts. The institution as reorganized is to receive the benefits of the acts of Congress of March 2, 1887, and August 30, 1890. The new board of managers was organized May 28, by the election of the following officers: C. O. Flagg president, Melville Bull treasurer, and C. J. Greene clerk.

UTAH STATION.—W. F. Brewer, M. D., formerly connected with the veterinary laboratory of the University of Nebraska, has been appointed biologist of the Utah Station.

VIRGINIA STATION.—R. H. Price, assistant horticulturist, has resigned to accept the position of professor of horticulture in the Texas College and horticulturist to the Texas Station.

RAIN-MAKING EXPERIMENTS IN 1891.—R. G. Dyrenforth's report on the rain-making experiments in 1891, under his direction, was issued as Ex. Doc. No. 45 of the Senate of the United States.

DAIRYING, P. DE VUYST.—Under this title the author publishes a 31-page pamphlet, made up of compiled notes and reports on investigations at Borsbeke, Belgium, and elsewhere, on (1) ripening of cream, (2) determination of acidity of cream, (3) rapid methods of determining fat in milk, and (4) new dairy apparatus.

Ripening of cream.—Cultures of bacteria were obtained from Dr. Weigmann of the Kiel Station. These were added to cream at the rate of 100 grams to 2.5 kg. of cream; other cultures propagated according to the directions of Weigmann were used at the same rate, and 2.5 kg. of cream were allowed to ripen naturally. At the end of twenty-four hours the cream had the same acidity, and each lot was churned at 13.5° C., the other conditions being as nearly identical as possible. In the first case the cream churned with difficulty, in the second case rather more satisfactorily, while in the third case it churned readily. The results of the tests were as follows:

Yield and composition of butter from cream ripened in different ways.

Method of ripening.	Yield of butter per 5 kg. of cream.	Fat in butter.
	Kg.	*Per ct.*
(1) Weigmann's cultures	1.17	76
Fresh cultures	1.26	84
Natural ripening	1.32	84
(2) Fresh cultures	1.25	....
Natural ripening	1.31	....
(3) Fresh cultures	1.38	80
Natural ripening	1.39	81
(4) Fresh cultures	1.20	....
Natural ripening	1.24	....

The butter prepared with Weigmann's cultures was of a better flavor while fresh than the other lots, but after two or three days rancidity was observed. There was, however, little difference in this respect between the butter prepared from cream ripened naturally and by means of the fresh cultures; and the results of experiments in other dairies in Belgium with fresh cultures show that while the quality of the fresh butter was slightly improved the yield was not sensibly increased.

The author concludes that under ordinary circumstances artificial ripening is of little value, but the new method may be employed with advantage in dairies where the conditions are unfavorable to the making of butter of good quality. Other experimenters have arrived at similar conclusions, but it appears probable that the trouble is due in large measure to the use of cultures which are not strictly pure, and to a neglect to maintain the proper temperatures during ripening. An automatic arrangement for controlling the temperature of the cream tanks during ripening is described and illustrated.

Determination of acidity of cream.—Brief directions for the use of various volumetric methods.

Rapid methods of determining fat in milk.—Compiled notes are given on the various milk tests which have been proposed in Europe and the United States, a number of which have been tested by the author. The methods of Demichel, Beimling, Babcock, and Thörner are described. Tests of a number of these methods have led to the conclusion that for dairies and coöperative creameries the Babcock and Beimling methods possess in a greater degree than others proposed the qualities of accuracy, simplicity, rapidity, and cheapness.

The author also describes a method of testing the hardness of butter, practically the same as that described by Parsons in Bulletin No. 13 of the New Hampshire Station (see Experiment Station Record, vol. III, p. 86).

New dairy apparatus.—Recent improvements in separators and butter extractors (particularly those of the De Laval model) are discussed. The Johansson extractor is illustrated and described at some length. The air churn of Rolland & Co. is described and its method of use explained. In this apparatus churning is accomplished by forcing a current of air through the milk or cream by means of a bellows communicating with the bottom of the churn. The inventors claim that this apparatus may be used in extracting butter from sweet milk, but experimental tests indicate that it works well only with sour milk. It consequently yields a sour skim milk, and in this respect it is at a disadvantage as compared with the separator. In some respects, however, the air churn is superior to the ordinary churn. Care must be taken that the air used is filtered, and the churn operated in a place free from bad odors.

THE LEFFMANN AND BEAM MILK TEST.—The method as described by the authors in the *Analyst* for May consists in dissolving the casein in 15 c. c. of milk with concentrated sulphuric acid and a mixture of equal parts of amyl alcohol and strong hydrochloric acid, and collecting the fat in the graduated neck of the test bottle by adding a mixture of hot water and sulphuric acid and whirling in a centrifugal machine. The method appears to be identical with the Beimling test in all essential details. No hot water is added in the Beimling test, and the graduation of the test bottle may be slightly different.

GERMAN AGRICULTURAL SOCIETY.—The annual meeting and fair of the German Agricultural Society is held this year at Königsberg, Prussia, June 16 to 20. The meetings and fairs of this Society are events of more than ordinary interest on account of the large number of agriculturists which they bring together, the number of prizes offered, and the extent and variety of the agricultural exhibits. The Society numbers at present over 7,000 members. The fair this year will include 347 horses, 814 head of cattle, 410 sheep, and 251 pigs, together with poultry, agricultural products of all descriptions, seeds, wines, apiary products, commercial fertilizers, commercial feeding stuffs, preserves, and over 2,300 machines and appliances. The meetings of the Society consist of day sessions, evening entertainments, and excursions, and are only open to members.

INTERNATIONAL CONGRESS OF SUGAR CHEMISTS.—At a meeting in the interest of sugar manufacture held in connection with the Vienna agricultural and forestry congress in 1889, the question of methods of analysis of sugars, molasses, etc., was discussed, and the desirability of uniform methods was universally conceded. An international congress of sugar chemists for this purpose was urged. The matter was finally placed in charge of F. Strohmer, director of the experiment station of the Central Society for Beet Sugar Industry in Austria-Hungary, who was given authority to canvass the situation and to arrange for a congress if sufficient support was received from chemists and manufacturers in different countries. A circular on this subject mailed to prominent sugar chemists and manufacturers in Germany, Holland, France, England, Russia, Italy, and America has elicited a large number of favorable replies. The united chemists of Belgium are endeavoring to arrange for a congress of sugar chemists at Brussels in 1893, and the question of uniting the two

congresses is being considered. At present it is believed that an international congress of sugar chemists will be held in Brussels in the spring of 1893.

REPORT OF THE DARMSTADT STATION FOR 1891.—Prof. Paul Wagner, the director of the station, reports the examination of 3,010 samples during 1891. Of these, 1,956 were fertilizing materials, 603 feeding stuffs, 325 seeds, and the remaining 126 miscellaneous. Serious cases of fraud and adulteration in the sale of fertilizers were noticed. Farmers are warned especially against purchasing Thomas slag from other than reliable firms, as adulteration of this phosphate is unusually common. Under the name of Thomas slag a material was sold closely resembling it in appearance, but believed to be "puddle slag." Although this contained phosphoric acid, none of it was in available form. Repeated attempts to render mineral phosphates more easily available by glowing and to give them the appearance and action of Thomas slag have usually resulted unsatisfactorily, although in one or two cases products have been secured of equal value with Thomas slag. The process was, however, found to be too expensive.

In addition to some 1,200 pot and plant experiments which were made during the year, a series of field experiments on a larger scale was commenced to study the application in practice of the theories suggested by the pot experiments.

Experiments have also been begun to compare the crude with the more concentrated agricultural chemicals, such as potassium phosphate, potassium nitrate, ammonium nitrate, and ammonium phosphate, which are now being extensively manufactured for fertilizing purposes. A report on these and on experiments in manuring fruits are promised in the next annual report.

LIST OF PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

ISSUED DURING JUNE, 1892.

DIVISION OF STATISTICS:

Report No. 96 (new series), June, 1892.—Report on the Acreage of Wheat and Cotton and Condition of Cereal Crops, and on Freight Rates of Transportation Companies.

DIVISION OF CHEMISTRY:

Bulletin No. 13.—Part VII, Foods and Food Adulterants—Tea, Coffee, and Chocolate Preparations.

Bulletin No. 33.—Experiments with Sugar Beets in 1891.

Bulletin No. 34.—Record of Experiments with Sorghum in 1891.

DIVISION OF ENTOMOLOGY:

Bulletin No. 26.—Reports of Observations and Experiments in the Practical Work of the Division of Entomology.

Insect Life, vol. IV, Nos. 9 and 10, June, 1892.

OFFICE OF EXPERIMENT STATIONS:

Experiment Station Record, vol. III, No. 10.

Bulletin No. 8.—Lectures on the Investigations at Rothamsted Experimental Station.

Bulletin No. 9.—The Fermentations of Milk.

DIVISION OF BOTANY:

Contributions from the United States National Herbarium, vol. II, No. 2.

OFFICE OF IRRIGATION INQUIRY:

Final Report of the Artesian and Underflow Investigation, parts I, II, III, and IV.

WEATHER BUREAU:

Bulletin No. 1.—Notes on the Climate and Meteorology of Death Valley, California.

Monthly Weather Review, March, 1392.

LIST OF STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS

DURING JUNE, 1892.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF CALIFORNIA:
Bulletin No. 97.—Investigations of California Prunes, Apricots, and Peaches.

COLORADO AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 19, May, 1892.—Observations upon Injurious Insects.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF ILLINOIS:
Bulletin No. 21, May, 1892.—Horticulture, a General Report; Corn-Crossing; Sweet Corn, Thickness of Planting, 1891; A Late Season and a Corn Crop.

IOWA AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 17, May, 1892.—Feeding Experiments with Milch Cows, Lambs, and Hogs; Sugar Beets for Iowa, 1891; Treatment of some Fungous Diseases—Experiments made in 1891; Effects of Spraying on Plants and Fruit, and Notes on Insects; Ergotism.

KANSAS AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 32, December, 1891.—Composition of Feeding Stuffs and of Certain Plants during Development; Test of some Japanese Beans; Plaster and Oil Meal as Fertilizers for Millet; Plaster for Grasses.

LOUISIANA AGRICULTURAL EXPERIMENT STATIONS:
Bulletin No. 15.—Report of Veterinarian.
Bulletin No. 16.—Annual Report for 1891 of the North Louisiana Experiment Station.

MAINE STATE COLLEGE AGRICULTURAL EXPERIMENT STATION:
Annual Report for 1891, parts II and III.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE:
Meteorological Bulletin No. 41, May, 1892.

AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF MINNESOTA:
Bulletin No. 20, May, 1892.—Fertilizers; Improvement of Timothy; Rape in Minnesota; Peas and Oats; Field Peas.
Bulletin No. 21, June, 1892.—Sugar Beets; Sorghum.

NEVADA AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 16, April, 1892.—The Creamery Industry.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 84, April 21, 1892.—Some Enemies of Truck and Garden Crops.
Bulletin No. 85, April 26, 1892.—The Late Crop of Irish Potatoes in the South.
Bulletin No. 86, May 2, 1892.—Tobacco Curing by the Leaf Cure on Wire and the Stalk Process.
Bulletin No. 86*a*, May 30, 1892.—Meteorological Summary for May, 1892.

OKLAHOMA AGRICULTURAL EXPERIMENT STATION:
Bulletin No. 2, March, 1892.—Station Work in Progress.

OREGON EXPERIMENT STATION:
Bulletin No. 19, May, 1892.—Some Oregon Weeds and how to Destroy Them.

South Dakota Agricultural Experiment Station:

Bulletin No. 29, December, 1891.—Forestry and Fungi.

Bulletin No. 30, March, 1892.—Report of Entomologist.

Agricultural Experiment Station of Utah:

Bulletin No. 13, May, 1892.—Feeding Hay and Grain Mixture to Horses; Feeding Cut Feed *vs.* Hay to Horses.

Bulletin No. 14, June 1, 1892.—Horticulture and Entomology.

Vermont State Agricultural Experiment Station:

Bulletin No. 29, May, 1892.—Analysis of Fertilizers Licensed for Sale in the State of Vermont in 1892.

Bulletin No. 30.—Results of the Bounty on Maple Sugar.

Virginia Agricultural and Mechanical College Experiment Station:

Bulletin No. 14, March, 1882.—Chemistry of the Tobacco Plant.

Bulletin No. 15, April, 1892.—Treatment of the Diseases of the Grape.

West Virginia Agricultural Experiment Station:

Bulletin No. 23.—Illustrated Descriptive List of Weeds.

DOMINION OF CANADA.

Ontario Agricultural College Experiment Station:

Bulletin No. 74, June 1, 1892.—Rape Culture.

Bureau of Industries, Toronto, Ontario:

Bulletin No. 41, June 9, 1892.—Crops in Ontario.

LIST OF STATION PUBLICATIONS ISSUED PRIOR TO JANUARY 1, 1892.

ALABAMA COLLEGE STATION.

Date.	Publication.	Title.
1883.		
October....	Bulletin No. 1...	Address of Commissioner of Agriculture and of J. S. Newman, Director, to the Farmers of Alabama.
1884.		
January ...	Bulletin No. 2...	Economy in Fertilization.
	Bulletin No. 3...	
	Bulletin No. 4...	
	Bulletin No. 5...	Phosphates of Alabama.
	Bulletin No. 6...	
1885.		
	Bulletin No. 7...	
	Bulletin No. 8...	
	Bulletin No. 9...	The Bollworm.
August....	Bulletin No. 10..	
	Bulletin No. 1...	
	Bulletin No. 2...	
	Bulletin No. 3...	Fertilizers.
	Bulletin No. 4...	Gardening.
1886.		
January ...	Bulletin No. 5...	Experiments for Clubs.
	Bulletin No. 6...	
	Bulletin No. 7...	
	Bulletin No. 8...	Analysis of Fertilizers.
	Bulletin No. 9*..	Analysis of Fertilizers.
1887.		
January...	Bulletin No. 1 ..	Experiments with Oats.
February ..	Bulletin No. 2 ..	[Experiments with Vegetables]. †
March......	Bulletin No. 3 ..	Experiments with Corn, 1886.
April.......	Bulletin No. 4 ..	Experiments with Cotton, 1886.
July........	Bulletin No. 5 ..	Experiments with Sweet Potatoes and Sugar Cane, 1886.
September .	Bulletin No. 6 ..	Experiments with Oats.
October....	Bulletin No. 7 ..	Experiments with Corn.
December..	Bulletin No. 8 ..	Analyses of Fertilizers.
1888.		
January ...	Bulletin No. 1 ..	Experiments with Corn.
	Bulletin No. 2 ..	Experiments with Small Fruits and Vegetables.
February ..	Bulletin No. 3 ..	Experiments with Cotton.
April......	Bulletin No. 4 ..	[Experiments with Fertilizers on Cotton].
June.......	Bulletin No. 5 ..	Effects of Fertilizers on Sweet Potatoes.
	NEW SERIES.	
July.......	Bulletin No. 1 ..	[Report of Lines of Work Pursued].
October....	Bulletin No. 2 ..	Report.
	Annual Report..	Annual Report, 1888.
1889.		
January ...	Bulletin No. 3...	Experiments with Corn; Vegetables; Analyses of Fertilizers. Soils, etc.; Woods of Alabama; Meteorology.
February ..	Bulletin No. 4...	Experiments in Horticulture.
April......	Bulletin No. 5...	Experiments with Cotton; Pig Feeding; Cattle Feeding; Analyses of Fertilizers; Meteorology.
July.......	Bulletin No. 6...	Grasses and their Cultivation.
October....	Bulletin No. 7...	Experiments with Vegetables; Methods of Setting Milk.
November .	Bulletin No. 8...	Commercial Fertilizers.
December..	Bulletin No. 9...	Nematode Root Galls. (Science contributions, Vol. I, No. 1.)
	Annual Report..	Annual Report, 1889.
1890.		
January ...	Bulletin No. 10..	Grape Culture.
February ..	Bulletin No. 11..	Notes from the Experiment Station Orchard.
February ..	Bulletin No. 12..	Coöperative Soil Tests.
March	Bulletin No. 13..	Microscopic study of Certain Varieties of Cotton.
April......	Bulletin No. 14..	Pea vines as a Fertilizer.
April......	Bulletin No. 15..	Kerosene Emulsion, How to Make and Apply it.
June.......	Bulletin No. 16..	Experiments with Fertilizers on Corn, Cotton, Rye, and Chufas.
July.......	Bulletin No. 17..	Dry Application of Paris Green and London Purple for the Cotton Worm; Report of the Alabama Weather Service.

* Files and records prior to 1887 were destroyed by fire.
† Titles which have been changed from their original form are inclosed in brackets.

List of station publications issued prior to January 1, 1892—Continued.

ALABAMA COLLEGE STATION—Continued.

Date.	Publication.	Title.
1890.		
August....	Bulletin No. 18..	Climatology of Alabama.
October....	Bulletin No. 19..	Roads and Road Making; Report of Weather Service.
November .	Bulletin No. 20..	Small Fruits, Melons, and Vegetables; Report of Weather Service.
December..	Bulletin No. 21..	A New Root-Rot Disease of Cotton; Report of Weather Service.
	Annual Report..	Annual Report, 1890.
1891.		
January ...	Bulletin No. 22..	Experiments with Cotton; Report of Weather Service.
February ..	Bulletin No. 23..	Coöperative Soil Tests with Fertilizers; Report of Weather Service.
February ..	Bulletin No. 24..	Dairying and Breeding; Report of Weather Service.
April	Bulletin No. 25..	Effects on Butter of Feeding Cotton Seed and Cotton-Seed Meal.
April	Bulletin No. 26..	Commercial Fertilizers.
May	Bulletin No. 27..	Black Rust of Cotton.
November .	Bulletin No. 28..	Watermelons and Cantaloupes.
November .	Bulletin No. 29..	Grapes, Raspberries, and Strawberries.
November .	Bulletin No. 30..	Apples, Pears, Peaches, and Plums.
November .	Bulletin No. 31..	Irish and Sweet Potatoes.
November .	Bulletin No. 32..	Corn, Wheat, and Oats.
December..	Bulletin No. 33..	Cotton.
	Annual Report..	Annual Report, 1891.

ALABAMA CANEBRAKE STATION.

Date.	Publication.	Title.
1888.		
July	Bulletin No. 1...	[Experiments with Vegetables].
October	Bulletin No. 2 ..	[Experiments with Vegetables and Fruit Trees].
	Annual Report..	First Annual Report, 1888.
1889.		
January ...	Bulletin No. 3...	Experiments with Corn; Forage Crops and Drainage.
April	Bulletin No. 4...	Experiments with Corn; Meteorology.
July	Bulletin No. 5...	Experiments with Oats, Wheat; Meteorological Report.
October	Bulletin No. 6...	Vegetables; Grapes; Meteorology.
	Annual Report..	Second Annual Report, 1889.
1890.		
February ..	Bulletin No. 7...	[Field Experiments with Cotton, Peas, Melilotus, and Corn].
April.. ..	Bulletin No. 8...	Cattle Feeding; Pig Feeding.
	Bulletin No. 9...	[Crops for Ensilage; Forage Plants and Grasses].
December..	Bulletin No. 10..	Experiments with Corn; Meteorology.
	Annual Report..	Third Annual Report, 1890.
1891.		
February ..	Bulletin No. 11..	Experiments with Cotton.
October	Bulletin No. 12..	Grapes, Strawberries, and Raspberries.
December..	Bulletin No. 13..	Corn.

ARIZONA STATION.

Date.	Publication.	Title.
1890.		
December..	Bulletin No. 1...	Organization of Station.
	Annual Report..	First Annual Report, 1890.
1891.		
September .	Bulletin No. 2...	Notes on some of the Range Grasses of Arizona; Overstocking the Range.
October	Bulletin No. 3...	Irrigation in Arizona
November .	Bulletin No. 4...	Waters and Water Analysis.
	Annual Report..	Second Annual Report, 1891.

ARKANSAS STATION.

Date.	Publication.	Title.
1888.		
March	Bulletin No. 1...	Cultivation of Cotton and Corn.
April	Bulletin No. 2...	Diseases of Animals.
April	Bulletin No. 3...	[Insects Injurious to Plant Life].
July	Bulletin No. 4...	Commercial Fertilizers.
August	Bulletin No. 5...	Dehorning.
August	Bulletin No. 6...	[Experiments with Wheat].
November .	Bulletin No. 7...	Horticulture.
	Annual Report.	First Annual Report, 1888.
1889.		
April	Bulletin No. 8...	Spaying of Cattle.
May	Bulletin No. 9...	Cotton Seed Hulls for Fattening.
June......	Bulletin No. 10..	[Insects and Insecticides].
September .	Bulletin No. 11..	[Strawberries and Cereals].
	Annual Report..	Second Annual Report, 1889.

List of station publications issued prior to January 1, 1892—Continued.

ARKANSAS STATION—Continued.

Date.	Publication.	Title.
1890.		
April	Bulletin No. 12	Influence of Spaying on Milk Production: Milk Analysis; Entomology.
August	Bulletin No. 13	Strawberries.
September	Bulletin No. 14	The Effects of the Arsenites upon Plants.
December	Bulletin No. 15	[New Insecticides for the Cotton Worm].
	Annual Report	Third Annual Report, 1890.
1891.		
July	Bulletin No. 16	Nature and Treatment of a Prevalent Skin Disease of Young Cattle.
October	Bulletin No. 17	Tests of Varieties of Grapes, Strawberries, Raspberries, and Plums.
	Annual Report	Fourth Annual Report, 1891.

CALIFORNIA STATION.*

Date.	Publication.	Title.
1875.		
February	Bulletin No. 8	Announcement of Lectures and Sketch of Outdoor Work.†
July	Bulletin No. 17	Thesis on Utility and Methods of Soil Analysis, by L. S. Burchard.
1876.		
January	Bulletin No. 23	Lecture on the Phylloxera or Grapevine Louse.
1877.		
April	Bulletin No. 26	Concerning Industrial Survey; Transmission of Soil Specimens, etc.
		Biennial Report, 1876 and 1877.
1878.		
	Bulletin No. 32	On the Destruction of the Ground Squirrel by the Use of Bisulphide of Carbon.
1879.		
	Biennial Report	Biennial Report, 1878 and 1879.
1880.		
	....	Phylloxera or the Grapevine Louse (revised reprint).
	Annual Report	Annual Report, 1880.
1882.		
	Biennial Report	Biennial Report, 1881 and 1882.
1884.		
January	Bulletin No. 1	Examination of the Water of the San Fernando Tunnel.
January	Bulletin No. 2	Plant Distribution.
January	Bulletin No. 3	Remedies for the Phylloxera; Failure of Cuttings.
January	Bulletin No. 4	Analyses of Tanning Materials.
February	Bulletin No. 5	[Distribution of Plants].
February	Bulletin No. 6	Comparative Examination of Claret Grapes from Fresno and Livermore Valley.
February	Bulletin No. 7	Examination of Irrigation Waters.
March	Bulletin No. 8	[Examinations of Fertilizing Materials and Soils].
April	Bulletin No. 9	Examination of Zinfandel Wines.
April	Bulletin No. 10	Examination of Soils.
May	Bulletin No. 11	On the Physical and Agricultural Features of California.
May	Bulletin No. 12	Examination of Zinfandel Wines.
August	Bulletin No. 13	[Examination of Red or Claret Wines].
August	Bulletin No. 14	Examinations of Artesian Waters from the San Joaquin Valley.
August	Bulletin No. 15	Examinations of Soils from Southern California.
September	Bulletin No. 16	Entomology in the College of Agriculture.
	Bulletin No. 17	The Muscat Grape on the Southern Mesas.
October	Bulletin No. 18	Mr. J. A. Bauer's Phylloxera Remedy.
October	Bulletin No. 19	Observations on the Phylloxera Made during 1884.
October	Bulletin No. 20	Examination of Stream and Well Waters.
	Bulletin No. 21	Examination of Red Wines from Sonoma and Napa Counties.
November	Bulletin No. 22	University Seed Distribution.
November	Bulletin No. 23	Vintage Work in the Viticultural Laboratory, 1884.
	Bulletin No. 24	Examinations of Grape-Growing Soils.
	Bulletin No. 25	Examinations of Alameda County Vineyard Soils.
December	Bulletin No. 26	Examinations of Miscellaneous Vegetable Substances.
December	Bulletin No. 27	Examinations of Soils from the Northern Coast Range Region.
	Bulletin No. 28	Examinations of Tule, Marsh, and Alkali Soils.
December	Bulletin No. 29	Distribution of Plants and Scions.
	Bulletin No. 30	Examination of Various Upland Soils.
	Biennial Report	Biennial Report, 1883 and 1884.
	Biennial Report	Report of the Viticultural Work, 1883 and 1884.
1885.		
January	Bulletin No. 31	Examination of Trousseau and Burger Wines.
February	Bulletin No. 32	Examination of Well and Spring Waters.
February	Bulletin No. 33	Examinations of Soils and Waters.
March	Bulletin No. 34	Experiments on the Growth of Cuttings from Wild American Vines.
April	Bulletin No. 35	Investigations of Wines from Rare Grape Varieties.
April	Bulletin No. 36	Examinations of Soils and Subsoils.

* The publications in this list from 1875 to 1882, inclusive, were issued as part of a general series of publications of the University of California.

† Summary of cultural station work prior to 1875.

List of station publications issued prior to January 1, 1892—**Continued.**

CALIFORNIA STATION—Continued.

Date.	Publication.	Title.
1885.		
April	Bulletin No. 37	Investigations of Wines from Rare Grape Varieties.—Cinsant, Petit Bouschet, Merlot, Verdot.
April	Bulletin No. 38	Investigations of Wines from Rare Grape Varieties.—Beelan, Cabernet, Franc, Cabernet Sauvignon.
May	Bulletin No. 39	Analyses of Oranges and Lemons from the Riverside Citrus Fair, March, 1885.
May	Bulletin No. 40	Investigations of Wines from Rare Grape Varieties.—Clairette Blanche, Roussanne, Marsanne.
June	Bulletin No. 41	The Olive.
August	Bulletin No. 42	Vintage Work in the Viticultural Laboratory, 1885.
September	Bulletin No. 43	Analyses of Santa Clara Valley Red Wines.
October	Bulletin No. 44	The "Bed-Rock Lands" of Sacramento County.
October	Bulletin No. 45	Grafting the California Wild Vine.
October	Bulletin No. 46	Grafting and Fruiting of Resistant Vines.
	Bulletin No. 47	Seed Distribution.
November	Bulletin No. 48	Investigations upon the Mercurial Phylloxera Remedy.
December	Bulletin No. 49	Examinations of Soils from the Bay Regions.
December	Bulletin No. 50	Distribution of Plants and Scions.
1886.		
January	Bulletin No. 51	The Wines of 1885.
February	Bulletin No. 52	Alkaline Washes for Fruit Trees.
February	Bulletin No. 53	Irrigation, Drainage, and Alkali.
April	Bulletin No. 54	Condensed Grape Must and its Uses.
May	Bulletin No. 55	The Woolly Aphis and its Repression.
May	Bulletin No 56	Whale-Oil Soap Insecticide Washes; The Sulphuring of Vines.
August	Bulletin No. 57	Vintage Work and Instruction in the Viticultural Laboratory, 1886.
October	Bulletin No. 58	The Hessian Fly and Resistant Grains.
November	Bulletin No. 59	[The Experimental Vineyard at Cupertino].
December	Bulletin No. 60	Colorimetric Measurement of Wines.
December	Bulletin No. 61	Distribution of Seeds and Plants.
December	Bulletin No. 62	Distribution of Cuttings and Scions.
	Biennial Report	Biennial Report, College of Agriculture, 1885, 1886. Alkali Lands, Irrigation and Drainage. App. VII.
	Biennial Report	Report of Viticultural Work during 1885–86.
1887.		
January	Bulletin No. 63	Experiments on Methods of Fermentation.
January	Bulletin No. 64	Planting and Grafting Resistant Vines.
February	Bulletin No. 65	Shall California Make Sophisticated Wines?
February	Bulletin No. 66	The Principles and Practice of Pasteurizing.
March	Bulletin No. 67	Misconception of the University Viticultural Work.
April	Bulletin No. 68	University Distribution of Seeds, Plants, etc; Influence of the Mode of Fermentation on the Color of Wines.
May	Bulletin No. 69	Wine Colors and Color Wines.
June	Bulletin No. 70	Abnormal Deposits on Vine Leaves; Mysterious Death of Vines; Remedy for the Anthracnose of Vines.
June	Bulletin No. 71	The Use of Gases against Scale Insects.
August	Bulletin No. 72	Sugar Beets at Fresno; The Hessian Fly and Resistant Grains.
August	Bulletin No. 73	The Use of Hydrocyanic Acid against Scale Insects.
August	Bulletin No. 74	Vintage Work and Instruction in the Viticultural Laboratory, 1887; The Choice of Resistant Stocks.
November	Bulletin No. 75	Spray and Band Treatments for the Codling Moth; Difficult Fermentations.
December	Bulletin No. 76	Distribution of Seeds and Plants.
December	Bulletin No. 77	The Extraction of Color and Tannin during Red-Wine Fermentation.
1888.		
March	Bulletin No. 78	Report on the Establishment of Outlying Stations.
May	Bulletin No. 79	Experiments on the Cause and Avoidance of Injury to Foliage in the Hydrocyanic Gas Treatment of Trees.
August	Bulletin No. 80	Progress of the Experiment Station Work.
December	Bulletin No. 81	Distribution of Seeds and Plants.
		Advance Sheets Annual Report, 1888. Methods of Fermentation and Related Subjects.
		Advance Sheets Annual Reports of 1888 and 1889; Waters, Water Supply, and Related Subjects.
1889.		
March		Circular concerning Analyses of Waters.
June	Bulletin No. 82	The Lakes of the San Joaquin Valley.
November	Bulletin No. 83	The Rise of Alkali in the San Joaquin Valley.
December	Bulletin No. 84	Distribution of Seeds and Plants.
	Biennial Report	Biennial Report, 1888–89.
1890.		
February	Bulletin No. 85	Observations on Olive Varieties.
May	Bulletin No. 86	Preservative Fluids for Fresh Fruits; The Sulphuring of Dried Fruits.
June	Bulletin No. 87	The Conservation of Wines.
October	Bulletin No. 88	The Use of Fertilizers in California.
December	Bulletin No. 89	Distribution of Seeds and Plants.
	Annual Report	Annual Report, 1890.

List of station publications issued prior to January 1, 1892—Continued.

CALIFORNIA STATION—Continued.

Date.	Publication.	Title.
1891.		
January ...	Bulletin No. 90..	Fiber Plants for California.
February ..	Bulletin No. 91..	Port and Sherry Grapes in California; Importation of Italian Grapes; Importation of Olives.
March	Bulletin No. 92..	Notes on California Olives, their Adaptations and Oils.
June	Bulletin No. 93..	Investigation of California Oranges and Lemons.
September.	Bulletin No. 94..	Composition of the Ramie Plant; Fertilizing Value of Greasewood.
December..	Bulletin No. 95..	Distribution of Seeds and Plants.

COLORADO STATION.

Date.	Publication.	Title.
1887.		
August....	Bulletin No. 1...	Reports of Experiments in Irrigation and Meteorology.
December..	Bulletin No. 2...	Grains, Grasses, and Vegetables.
December..	Bulletin No. 3...	Distribution of College Seeds and Plants; Duties of Secretary of State Board of Agriculture.
1888.		
February ..	Bulletin No. 4...	Experiments with Potatoes and Tobacco.
October....	Bulletin No. 5...	Experiments in Apiary.
	Annual Report .	First Annual Report, 1888.
1889.		
January ...	Bulletin No. 6...	Insects and Insecticides.
April	Bulletin No. 7...	Potatoes and Sugar Beets.
July	Bulletin No. 8...	Alfalfa, its Growth, Composition, Digestibility, etc.
October....	Bulletin No. 9...	Soils and Alkali.
	Annual Report .	Second Annual Report, 1889.
1890.		
January ...	Bulletin No. 10..	Tobacco.
April	Bulletin No. 11..	Sugar Beets.
July	Bulletin No. 12..	Some Colorado Grasses and their Chemical Analysis.
October....	Bulletin No. 13..	The Measurement and Division of Water.
	Annual Report .	Third Annual Report, 1890.
1891.		
January ...	Bulletin No. 14..	Sugar Beets.
April	Bulletin No. 15..	Codling Moth and Grapevine Leaf Hopper.
July	Bulletin No. 16..	The Artesian Wells of Colorado and their Relation to Irrigation.
October....	Bulletin No. 17..	Fruit Interests of the State.
December..	Bulletin No. 18 .	Index to Bulletins Nos. 1-17.

CONNECTICUT STATE STATION.

Date.	Publication.	Title.
1876.		
	Prelim Report*.	Preliminary Work; Fertilizers, etc.
	Annual Report*.	First Annual Report (a supplementary report on experiments at Middletown was published in the Report of the Connecticut Board of Agriculture for 1878).
1877.		
	Annual Report .	Annual Report, 1877.
1877-78.		
	Bulletins Nos. 1-8.	Fertilizer Analyses.
	Bulletin No. 9...	Fertilizers and "Egg Food."
	Annual Report .	Annual Report, 1878.
1878-79.		
	Bulletins Nos. 10-22.	Fertilizer Analyses.
	Bulletin No. 23..	Analyses of Hay.
	Bulletins Nos. 24-33.	Fertilizer Analyses.
	Bulletin No. 34..	Analyses of Hay.
	Bulletin No. 35..	Analyses of Maize Kernels.
	Annual Report .	Annual Report, 1879.
1880.		
	Bulletin No. 36..	Shell Marl, Oyster Shell Lime, Marine Mud, and Seaweed.
	Bulletin No. 37..	Fresh Water Sediments; Peat or Swamp Muck.
	Bulletins Nos. 38-48.	Fertilizer Analyses.
	Bulletin No. 49..	Swamp Muck.
	Bulletin No. 50..	Fertilizers.
	Annual Report .	Annual Report, 1880.
1881.		
	Bulletin No. 51..	Refuse Lime; Sorghum Seed; Brewers' Grains.
	Bulletin No. 52 .	Cost of Active Ingredients of Fertilizers.
	Bulletin No. 53..	Shell Marl; Apple Pomace.
	Bulletin No. 54..	Fertilizers.

* During 1875 and 1876 the station was at Middletown.

List of station publications issued prior to January 1, 1892—**Continued.**

CONNECTICUT STATE STATION—Continued.

Date.	Publication.	Title.
1881.		
	Bulletin No. 55	Night Soil: Ensilage.
	Annual Report	Annual Report for 1881.
1881-83.		
	Bulletins Nos. 56-76.	Fertilizer Analyses.
	Annual Reports	Annual Reports, 1882 and 1883.
1884.		
	Bulletin No. 77	Fertilizers; Composition of Peach Wood, Healthy and Diseased.
1884-85.	Bulletins Nos. 78-85.	Fertilizer Analyses.
	Annual Reports	Annual Reports, 1884 and 1885.
1886.		
January	Bulletin No. 86	Analyses of Fertilizers; Analyses of Feeding Stuffs.
March	Bulletin No. 87	Analyses of Fertilizers; Analyses of Feeding Stuffs.
July	Bulletin No. 88	Analyses of Commercial Fertilizers.
October	Bulletin No. 89	Analyses of Superphosphates and Special Manures.
	Annual Report	Annual Report for 1886.
1887.		
March	Bulletin No. 90	Valuation of Fertilizers.
April	Bulletin No. 91	Analyses of Fertilizers.
September	Bulletin No. 92	Observance of the Fertilizer Law.
November	Bulletin No. 93	Classification of Plants and Grasses.
	Annual Report	Annual Report for 1887.
1888.		
April	Bulletin No. 94	The Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals for 1888.
June	Bulletin No. 95	Analyses of Fertilizers.
	Annual Report	Annual Report for 1888.
1889.		
January	Bulletin No. 96	On the Valuation of Feeding Stuffs.
April	Bulletin No. 97	Fungous Diseases of Plants; Analyses of Fertilizers.
June	Bulletin No. 98	Analyses of Fertilizers; Home-mixed.
June	Bulletin No. 99	Analyses of Fertilizers.
September	Bulletin No. 100	Analyses and Valuations of Fertilizers.
	Annual Report	Annual Report for 1889.
1890.		
January	Bulletin No. 101	Fertilizer Analyses.
March	Bulletin No. 102	Fungicides.
May	Bulletin No. 103	Fertilizers.
October	Bulletin No. 104	Fertilizer Analyses.
December	Bulletin No. 105	Potato Scab; The Proteids or Albuminoids of the Oat Kernel.
	Annual Report	Annual Report for 1890.
1891.		
March	Bulletin No. 106	The Babcock Method of Determining Fat in Milk and Cream; Butter Analyses; Fertilizers.
April	Bulletin No. 107	The Connecticut Species of Gymnosporangium.
May	Bulletin No. 108	Examination of the Seed of Orchard Grass; Ash Analysis of White Globe Onions; on the Determination of Fat in Cream by the Babcock Method.
August	Bulletin No. 109	Fertilizers.
December	Bulletin No. 110	Canada Ashes.
	Annual Report	Annual Report, 1891.

CONNECTICUT STORRS STATION.

1888.		
June	Bulletin No. 1	Field Experiments; Organization.
October	Bulletin No. 2	Experiments on the Effects of Tillage; Soil Moisture; Grass and Forage Garden.
	Annual Report	First Annual Report, 1888.
1889.		
February	Bulletin No. 3	Roots of Plants as Manure.
July	Bulletin No. 4	Meteorological Observations; Bacteria in Milk and its Products.
October	Bulletin No. 5	Atmospheric Nitrogen as Plant Food.
	Annual Report	Second Annual Report, 1889.
1890.		
August	Bulletin No. 6	Grasses and Legumes; Grass and Forage Garden.
	Annual Report	Third Annual Report, 1890.
1891.		
September	Bulletin No. 7	Chemistry and Economy of Food.
	Annual Report	Fourth Annual Report, 1891.

List of station publications issued prior to January 1, 1892—Continued.

DELAWARE STATION.

Date.	Publication.	Title.
1888.		
June	Bulletin No. 1	Objects and Organization of Station.
September	Bulletin No. 2	Horticulture and Entomology.
December	Bulletin No. 3	[Botany and Plant Pathology].
	Annual Report	First Annual Report, 1888.
1889.		
May	Bulletin No. 4	Injurious Insects, their Identification and Extermination.
June	Bulletin No. 5	Inspection of Seed and of Stock Feed in Delaware.
October	Bulletin No. 6	A Summary of the Station Experiments on the Black Rot of Grapes.
December	Bulletin No. 7	Stock Feeding.
	Annual Report	Second Annual Report, 1889.
1890.		
March	Bulletin No. 8	Experiments to Test the Possibility of Developing a Domestic Sugar Industry; Spraying with Sulphide of Potassium for Peach Scab; London Purple for the Codling Moth.
March	Spec. Bulletin A	Fungicides.
	Bulletin No. 9	Creamery Studies of Methods and Machinery.
October	Bulletin No. 10	Diseases of the Vine Controlled by Several Different Salts of Copper.
	Annual Report	Third Annual Report, 1890.
1891.		
January	Bulletin No. 11	Soil and Crop Tests.
March	Bulletin No. 12	Injurious Insects and Insecticides.
July	Bulletin No. 13	Leaf Blight of the Pear and the Quince.

FLORIDA STATION.

Date.	Publication.	Title.
1888.		
April	Bulletin No. 1	Grasses, Vegetables, Cereals, and Flowers.
May, June	Bulletin No. 2	Reports of Departments of Station.
September	Bulletin No. 3	Experiments with Fertilizers.
1889.		
January	Bulletin No. 4	Peach Growing in Florida; Annual Report, 1888.
April	Bulletin No. 5	Analyses of Fertilizers.
July	Bulletin No. 6	General Report of Chemist.
October	Bulletin No. 7	[Experiments with Corn; Analyses of Muck].
1890.		
January	Bulletin No. 8	Field Experiments with Cotton; Weeds of Florida; Annual Report, 1889.
April	Bulletin No. 9	Entomological Notes.
July	Bulletin No. 10	Report of Director; Phosphates.
October	Bulletin No. 11	[Corn Experiments; Potato Experiments; Analyses of some Florida Weeds and Grasses].
	Annual Report	Annual Report, 1890.
1891.		
January	Bulletin No. 12	Tobacco, Cotton, Rice, and Sorghum; Ashes as a Fertilizer; Miscellaneous Analyses.
April	Bulletin No. 13	Experiments with Potatoes and Rye; Composition and Value of Certain Materials for Fertilizing Purposes.
July	Bulletin No. 14	Annual Report; Horticulture, Cereals, Stock, etc.
October	Bulletin No. 15	Tobacco and its Cultivation.

GEORGIA STATION.

Date.	Publication.	Title.
1888.		
October	Bulletin No. 1	[Outline of Work, and History].
	Annual Report	First Annual Report, 1888.
1889.		
January	Bulletin No. 2	Ash Analyses of Native Woods; Experiments with Phosphates and Kainit on Cotton; Preservation of the Sweet Potato in Winter.
April	Bulletin No. 3	Notes on Various Insects and Remedies; Ash Analyses of Native Woods; Cowpea as a Fertilizing Crop; Preservation of the Sweet Potato in Winter.
July	Bulletin No. 4	Analyses of Cattle Food.
October	Bulletin No. 5	[Reorganization of Station].
	Annual Report	Second Annual Report, 1889.
1890.		
January	Bulletin No. 6	Entomology; "Southern Drift" and its Agricultural Relations.
April	Bulletin No. 7	[Analyses of Feeding Stuffs; Notes on a Destructive Insect].
July	Bulletin No. 8	[Potato Experiments].
October	Bulletin No. 9	Potash and Paying Crops.
December	Bulletin No. 10	[Fertilizer Experiments on Corn].
	Annual Report	Third Annual Report, 1890.

List of station publications issued prior to January 1, 1892—**Continued.**

GEORGIA STATION—Continued.

Date.	Publication.	Title.
1891.		
January	Bulletin No. 11	Cotton Fertilizers and Culture Experiments; Experiments in the Culture of Sweet Potatoes, etc.
April	Bulletin No. 12	Field Experiments with Forage Plants and Analyses of the Products.
July	Bulletin No. 12½	Circular to the Farmers of Georgia from the Board of Directors.
July	Bulletin No. 13	Analyses of Feeding Stuffs.
October	Bulletin No. 14	Variety and Fertilizer Experiments with Oats; Variety Tests with Wheat; Variety Tests and Fertilizer Experiments with Vegetables.
December	Bulletin No. 15	Fertilizer, Culture, and Variety Experiments on Corn; Culture of Small Fruits.
	Annual Report	Fourth Annual Report, 1891.

ILLINOIS STATION.

Date.	Publication.	Title.
1885.		
September	Bulletin No. 1*	Economical Rearing and Feeding of Cattle.
1886.		
January	Bulletin No. 2*	Report of the Horticultural Department.
1887.		
November	Bulletin No. 3*	On the Moisture of the Soil and its Relations to Tile Drainage and Cultivation.
December	Bulletin No. 4*	Experiments in Feeding Pigs, Winter of 1886–87.
1888.		
May	Bulletin No. 1	General Outline of Work.
August	Bulletin No. 2	Ensilage.
November	Bulletin No. 3	Field Experiments in Oats.
	Annual Report	First Annual Report, 1888.
1889.		
February	Bulletin No. 4	Field Experiments with Corn.
May	Bulletin No. 5	Grasses and Clovers.
August	Bulletin No. 6	A Bacterial Disease of Corn.
November	Bulletin No. 7	The Biology of Ensilage.
	Annual Report	Second Annual Report, 1889.
1890.		
February	Bulletin No. 8	Field Experiments with Corn.
May	Bulletin No. 9	Milk and Butter Tests; the Comparative Value of Corn Fodder and Ensilage in Feeding Yearling Heifers; Value of Pasturage and Grain Ration with Pasturage for Young Cattle.
August	Bulletin No. 10	Investigation of Milk Tests.
August	Bulletin No. 11	Experiments with Wheat.
November	Bulletin No. 12	Field Experiments with Oats; Cream Raising by Dilution; Milk and Butter Tests; The Hessian Fly; Canada Thistles.
	Annual Report	Third Annual Report, 1890.
1891.		
February	Bulletin No. 13	Field Experiments with Corn.
February	Bulletin No. 14	Milk Tests; Chemical Analyses of "Germ Meal" and Oat-Dust Feed.
February	Bulletin No. 15	Fruit Bark Beetle; Experiments with Grass Seeds; Use of Fungicides upon the Apple, Potato, and Grape.
May	Bulletin No. 16	Experiments in Pig Feeding; Composite Milk Samples Tested for Butter Fats.
August	Bulletin No. 17	Experiments with Wheat, 1890–91; Daily Variations in Milk and Butter Production of Cows.
November	Bulletin No. 18	Dairying Experiments.
	Annual Report	Annual Report, 1890–91.

INDIANA STATION.†

Date.	Publication.	Title.
1875–83	Annual Reports	Annual Reports, 1875–1883.
1884.		
December	Bulletin No. 1	Report on Hessian Fly.
	Bulletin No. 2	Report on Experiments with Various Commercial Fertilizers on Corn and Potatoes.
	Annual Report†	Annual Report, 1884.
1885.		
April	Bulletin No. 3	Reports on Insects Affecting Growing Wheat.
September	Bulletin No. 4	Report on Experiments with Wheat.
November	Bulletin No. 5	Report on Experiments with Small Fruits.
	Annual Report	Annual Report, 1885.
1886.		
March	Bulletin No. 6	Report on Experiments with Oats and Corn.

*Issued as bulletins of the University of Illinois.

†The publications for the years 1875 to 1887, inclusive, were issued by the School of Agriculture of Purdue University.

List of station publications issued prior to January 1, 1892—**Continued.**

INDIANA STATION—Continued.

Date.	Publication.	Title.
1886.		
May	Bulletin No. 7	Report on Experiments with Oats and Corn; Notes on Commercial Fertilizers and Agricultural Chemistry.
August	Bulletin No. 8	Report on Experiments with Wheat.
October	Bulletin No. 9	The American Meromyza.
December	Bulletin No. 10	Report on Horticultural Experiment Stations.
	Annual Report	Annual Report, 1886.
1887.		
May	Bulletin No. 11	Commercial Fertilizers.
August	Bulletin No. 12	Experiments with Wheat.
	Annual Report	Annual Report, 1887.
1888.		
January	Bulletin No. 13	Report of New Organization.
April	Bulletin No. 14	Experiments with Oats and Corn.
June	Bulletin No. 15	Report Concerning the Potato Tuber.
August	Bulletin No. 16	Experiments with Wheat; Crop Rotations.
November	Bulletin No. 17	Parturient Apoplexy.
	Annual Report	First Annual Report (of Station), 1888.
1889.		
January	Bulletin No. 18	Experiments with Vegetables.
	Bulletin No. 19	Spotting of Peaches and Cucumbers.
	Bulletin No. 20	Experiments in Cross-Fertilization and the Culture of Tropical Ferns.
February	Bulletin No. 21	Rational Feeding.
March	Bulletin No. 22	Commercial Fertilizers.
April	Bulletin No. 23	Experiments with Corn.
May	Bulletin No. 24	Experiments on Milk Production.
June	Bulletin No. 25	Entomological Experiments.
July	Bulletin No. 26	Wheat Rust.
August	Bulletin No. 27	Field Experiments with Wheat.
September	Bulletin No. 28	Smut of Wheat and Oats.
December	Bulletin No. 29	Grasses of Indiana.
	Annual Report	Second Annual Report, 1889.
1890.		
February	Bulletin No. 30	Influenza.
April	Bulletin No. 31	Small Fruits and Vegetables.
July	Bulletin No. 32	Treatment of Smut in Wheat; Field Experiments with Wheat; Two Expensive Fertilizers.
October	Bulletin No. 33	Small Fruits; Entomological Notes; Absorptive Power of Soils.
	Annual Report	Third Annual Report, 1890.
1891.		
February	Bulletin No. 34	Sugar Beets; Field Experiments with Fertilizers on Barley and Oats; Tests of Vegetables.
March	Bulletin No. 35	Loose Smut of Oats.
August	Bulletin No. 36	Field Experiments with Wheat; Testing Grain; Wheat Scab; Forms of Nitrogen for Wheat.
December	Bulletin No. 37	Steer Feeding; Indiana Feeding Stuffs.
	Annual Report	Fourth Annual Report, 1891.

IOWA STATION.

1888.		
May	Bulletin No. 1	Organization and Plans; Notes on Crossing
September	Bulletin No. 2	Corn Tassels, Silks, and Blades; Grasses and other Foliage Plants; A Few Important Chinch Bug Remedies.
November	Bulletin No. 3	Reports of Departments.
	Annual Report	First Annual Report, 1888.
1889.		
February	Bulletin No. 4	[Horticultural Report; Some Suggestions Concerning the Corn Root Worm].
May	Bulletin No. 5	[Sorghum; Insects and Insecticides].
August	Bulletin No. 6	Wheat and Oats; Feeding Experiments; Food Habits of Striped Prairie Squirrels.
November	Bulletin No. 7	Experiments with Corn; The Millets; Sugar Experiments; Codling Moth Experiments; New Cynipidæ; The Hog Louse; The College Vineyard.
	Annual Report	Second Annual Report, 1889.
1890.		
February	Bulletin No. 8	Iowa Station Milk Test; Sweet-Cream Butter; Sugar Beets; Sorghum.
May	Bulletin No. 9	Comparative Value of Fodder Plants and Other Feeding Stuffs; Iowa Station Milk Test—a Correction; The Relative Value Plan at Creameries; Plum Curculio and Plum Gouger.
August	Bulletin No. 10	Our Rusted and Blighted Wheat, Oats, and Barley in 1890; Experiments with Arsenites; Stocks for the Cherry, Plum, Prune, and Apricot; A Chemical Study of Blue Grass; Corn Fodder.

List of station publications issued prior to January 1, 1892—Continued.

IOWA STATION—Continued.

Date.	Publication.	Title.
1890.		
November .	Bulletin No. 11..	Experiments in Making and Storing Hay; Cultivated and Wild Varieties of Grasses in Iowa; Creamery and Dairy Notes; Potato Stalk Weevil, Apple Curculio, and a New Currant Borer; Kerosene Emulsion as Sheep Dip and as a Destroyer of Parasites on Domestic Animals; Third Annual Report. 1890.
1891.		
February ..	Bulletin No. 12..	Experiments with Potatoes, Sugar Beets, Sorghum; Insects and Insecticides; Feeding Experiments.
May	Bulletin No. 13..	Experiment in Feeding for Milk; Treatment of Fungous Diseases; Some Insects Destructive to Grass; Blossoms of the Orchard Fruits, their Relative Hardiness; Some Observations on Contaminated Water Supply for Stock.
August....	Bulletin No. 14..	Effect of Food upon the Quality of Milk; Calf Feeding Experiment; A Feeding Experiment for Milk; Hog Experiment No. 1; Reports on Entomological Work; Breeding of the Orchard and Garden Fruits; An Apthous Affection among Dairy Cows of the State.
November .	Bulletin No. 15..	Sugar Beets; Injurious Insects; Soiling Experiment; Time of Sowing Grass Seed; Winter Wheat; Best Varieties of Oats; Fertilizers.

KANSAS STATION.

1888.		
April	Bulletin No. 1...	Outline of Work.
April	Bulletin No. 2...	Cultivated Grasses and Clovers in Kansas.
June.......	Bulletin No. 3...	Observations on two Insect Pests.
September .	Bulletin No. 4...	Experiments with Wheat.
December .	Bulletin No. 5...	Some Comparisons of Varieties of Sorghum; Preliminary Report on Sorghum Blight.
	Annual Report .	First Annual Report, 1888.
1889.		
June.......	Bulletin No. 6...	Silos and Silage.
July	Bulletin No. 7...	Experiments with Wheat.
October....	Bulletin No. 8...	Preliminary Report on Smut in Oats.
December .	Bulletin No. 9...	Experiments in Pig Feeding.
	Annual Report .	Second Annual Report, 1889.
1890.		
May	Bulletin No. 10..	Notes on Conifers.
July	Bulletin No. 11..	Experiments with Wheat.
August....	Bulletin No. 12..	Preliminary Experiments with Fungicides for Stinking Smut of Wheat.
August....	Bulletin No. 13..	Experiments with Oats.
December .	Bulletin No. 14..	Winter Protection of the Peach Tree; Notes on Grapes.
December .	Bulletin No. 15..	Additional Experiments and Observations on Oat Smut made in 1890.
December .	Bulletin No. 16..	Experiments with Sorghum and Sugar Beets.
December .	Bulletin No. 17..	Crossed Varieties of Corn, Second and Third Years.
December .	Bulletin No. 18..	Experiments with Forage Plants.
	Bulletin No. 19..	[Notes on Vegetables].
	Annual Report .	Third Annual Report, 1890.
1891.		
July	Bulletin No. 20..	Experiments with Wheat.
August....	Bulletin No. 21..	Second Report on Fungicides for Stinking Smut of Wheat.
August....	Bulletin No. 22..	Smut of Oats in 1891; Test of Fungicides to Prevent Loose Smut of Wheat; Spraying to Prevent Wheat Rust.
August....	Bulletin No. 23..	Smuts of Sorghum; Corn Smut.
September .	Bulletin No. 24..	Enzoötic Cerebritis or "Staggers" of Horses.
December..	Bulletin No. 25..	Experiments with Sorghum.
December..	Bulletin No. 26..	A Comparison of the Varieties of the Strawberry.
December..	Bulletin No. 27..	Crossed Varieties of Corn, Third Year.
December..	Bulletin No. 28..	Second Report on Station Vineyard.
December..	Bulletin No. 29..	Experiment with Oats.
December..	Bulletin No. 30..	Experiment with Corn.
December..	Bulletin No. 31..	Sugar Beets.
December..	Bulletin No. 32..	Analyses of Feeding Stuffs; Composition of Cereals at Different Stages of Growth; Tests of Japanese Beans; Plaster and Oil Meal as Fertilizers for Millet; Plaster as a Fertilizer for Grasses.
	Annual Report .	Fourth Annual Report, 1891.

KENTUCKY STATION.

1885.		
December .	Bulletin No. 1...	Do Fertilizers Affect the Quality of Tobacco?
1886.		
January ...	Bulletin No. 2...	Corn Fodder as Food for Stock.
	Bulletin No. 3...	Milk.
	Bulletin No. 4...	Distillery Slop.

List of station publications issued prior to January 1, 1892—**Continued.**

KENTUCKY STATION—Continued.

Date.	Publication.	Title.
1886.		
January ...	Bulletin No. 5...	Analyses of Feeding Stuffs.
	Bulletin No. 6...	Clover.
September.	Bulletin No. 7...	Fertilizers.
September.	Bulletin No. 8...	Experiments with Wheat.
1887.		
March.....	Bulletin No. 9...	Experiments with Potatoes.
May	Bulletin No. 10..	Fertilizer Analyses.
September.	Bulletin No. 11..	Wheat Experiments.
December .	Bulletin No. 12..	Fertilizer Analyses.
1888.		
April......	Bulletin No. 13..	Commercial Fertilizers.
July.......	Bulletin No. 14..	Artificial or Commercial Fertilizers.
September.	Bulletin No. 15..	Experiments with Wheat.
December..	Bulletin No. 16..	Potato Experiments.
	Annual Report .	First Annual Report, 1888.
1889.		
February ..	Bulletin No. 17..	Corn Experiments.
April......	Bulletin No. 18..	Hemp Experiments; Notes on the Treatment of an Old Apple Orchard.
May	Bulletin No. 19..	Experiments in Pig Feeding.
July	Bulletin No. 20..	Commercial Fertilizers.
September .	Bulletin No. 21..	Wheat Experiments; The Grain Louse.
December..	Bulletin No. 22..	Potato Experiments.
	Annual Report .	Second Annual Report, 1889.
1890.		
February ..	Bulletin No. 23..	Experiments with Oats; Fertilizers on Meadow Land.
March	Bulletin No. 24..	The Broom Rape of Hemp and Tobacco.
April	Bulletin No. 25..	Strawberries.
April	Bulletin No. 26..	Experiments with Corn.
April	Bulletin No. 27..	Experiments with Commercial Fertilizers on Hemp.
May	Bulletin No. 28..	Experiments with Fertilizers on Tobacco.
July	Bulletin No. 29..	Commercial Fertilizers.
August....	Bulletin No. 30..	Experiments with Wheat; A New Wheat Fly.
December..	Bulletin No. 31..	Some Strawberry Pests.
1891.		
March	Bulletin No. 32..	Strawberries and Vegetables.
April	Bulletin No. 33..	Field Experiments with Fertilizers on Corn.
August....	Bulletin No. 34..	Commercial Fertilizers.
September .	Bulletin No. 35..	Experiments with Wheat; Experiments with Oats.
December..	Bulletin No. 36..	Commercial Fertilizers.
December..	Bulletin No. 37..	Experiments with Potatoes.

LOUISIANA STATIONS.

1885.		
	Bulletin No. 1...	Outline of Station Work.
1886.		
January ...	Bulletin No. 2...	[Manures].
April	Bulletin No. 3...	[Field Experiments].
July	Bulletin No. 4...	Oats.
December..	Bulletin No. 5...	Sorghum.
December..	Bulletin No. 6...	Corn.
1887.		
January ...	Bulletin No. 7...	Sugar Cane.
March	Bulletin No. 8...	Cotton.
April	Bulletin No. 9...	Analyses and Valuation of Fertilizers; Crop Report.
	Bulletin No. 10..	Sugar Cane.
	Bulletin No. 11..	Oats and Potatoes.
1888.		
January ...	Bulletin No. 12..	Sorghum.
	Bulletin No. 13..	Cotton and its Products.
January ...	Bulletin No. 14..	Sugar Cane.
	Bulletin No. 15..	Rice.
September.	Bulletin No. 16..	Potatoes, Tomatoes, Peas, and Small Grains.
October....	Bulletin No. 17..	Ensilage.
October....	Bulletin No. 18..	Analyses of Commercial Fertilizers.
December..	Bulletin No. 19..	Sorghum, Field, Laboratory, and Sugarhouse Results.
	Annual Report .	First Annual Report, 1888.
1889.		
January ...	Bulletin No. 20..	Sugar Cane Field Experiments.
January ...	Bulletin No. 21..	Report of the State Station for 1888.
January ...	Bulletin No. 22..	Annual Report of North Louisiana Experiment Station, 1888.
	Bulletin No. 23..	Sugar Cane—Diffusion Process.
	Bulletin No. 24..	Rice and its By-Products.
	Bulletin No. 25..	Analyses of Commercial Fertilizers and Other Substances Useful to Agriculture.

List of station publications issued prior to January 1, 1892—Continued.

LOUISIANA STATIONS—Continued.

Date.	Publication.	Title.
1889.		
January ...	Bulletin No. 26..	Report of the State Experiment Station for 1889.
	Bulletin No. 27..	Report of the North Louisiana Experiment Station for 1889.
	Bulletin No. 28..	Field Experiments on Sugar Cane; Report of Sugar Station, 1889.
	Annual Report.	Second Annual Report, State Station, 1889.
	SECOND SERIES.	
1890.		
September.	Bulletin No. 1...	Analyses of Commercial Fertilizers and Other Substances Useful to Agriculture.
	Bulletin No. 2...	Texas Screw Worm.
	Bulletin No. 3...	Report of Horticultural Department.
	Bulletin No. 4...	Irish Potatoes.
	Annual Report.	Third Annual Report, 1890.
1891.		
	Bulletin No. 5...	Sugar Making on a Small Scale.
January ...	Bulletin No. 6...	Field Experiments with Sugar Cane.
January ...	Bulletin No. 7...	Report of State Station.
January ...	Bulletin No. 8...	Report of North Louisiana Station.
	Bulletin No. 9...	Sugar Cane Borer and its Parasite.
	Bulletin No. 10.	Systematic Feeding of Work Stock as Preventive of Disease; Some Diseases of Farm Animals.
September.	Bulletin No. 11..	Report of the Sugarhouse and Laboratory for 1890.
September.	Bulletin No. 12..	Analyses of Commercial Fertilizers and Other Substances Useful to Agriculture.
	Annual Report.	Fourth Annual Report, 1891.

MAINE STATION.

Date.	Publication.	Title.
1885.		
May	Bulletin No. 1...	Analysis and Valuation of Commercial Fertilizers.
August	Bulletin No. 2...	Remarks on Valuation of Commercial Fertilizers.
November.	Bulletin No. 3...	Analyses of Ashes from Various Sources.
December..	Bulletin No. 4...	Analysis of Harbor Mud and Wood Ashes.
	Annual Report.	Annual Report, 1885.
1886.		
January ...	Bulletin No. 5...	Examination of Condimental Cattle Foods.
April	Bulletin No. 6...	The Valuation of Fertilizers.
April	Bulletin No. 7...	Results of Analyses of Fertilizers.
May	Bulletin No. 8...	Estimated Values of Fertilizers.
July	Bulletin No. 9...	Fertilizer Analyses.
October....	Bulletin No. 10.	Analyses of Molasses.
October....	Bulletin No. 11	Field Experiments with Fertilizers.
October....	Bulletin No. 12..	Comparative Production from Different Forms of Phosphoric Acid.
October....	Bulletin No. 13..	Experiments with Fertilizers.
	Annual Report.	Annual Report, 1885-86.
1887.		
January ...	Bulletin No. 14..	Insecticides.
February.	Bulletin No. 15..	Feeding Experiments.
February ..	Bulletin No. 16..	Feeding Stuffs.
March	Bulletin No. 17..	Fertilizers.
April	Bulletin No. 18..	Potatoes, Oats, and Barley.
April	Bulletin No. 19..	Fertilizers.
May	Bulletin No. 20..	Fertilizers.
December..	Bulletin No. 21..	Condition of Station.
	Annual Report.	Annual Report, 1886-87.
1888.		
March	Bulletin No. 22..	Organization and Work of the Station.
April	Bulletin No. 23..	Inspection of Fertilizers.
May	Bulletin No. 24..	Tests of Varieties.
August	Bulletin No. 25..	Analyses of Fertilizers Sold in the State
October. ..	Bulletin No. 26..	Composition and Digestibility of Certain Cattle Food
	Annual Report.	Annual Report, 1888.
	SECOND SERIES.	
1889.		
May	Bulletin No. 1...	Analyses of Commercial Fertilizers.
	Bulletin No. 2...	The Apple Maggot.
	Annual Report.	Annual Report, 1889, Parts I, II, and III.
1890.		
	Annual Report.	Annual Report, 1890, Parts I, II, III, and IV.
1891.		
September.	Bulletin No. 3..	The Babcock Milk Test, Adapted to Testing Cream,
	Annual Report	Annual Report, 1891, Parts I, II, and III.

List of station publications issued prior to January 1, 1892—Continued.

MARYLAND STATION.

Date.	Publication.	Title.
1888.		
June	Bulletin No. 1	History, Organization, and Work of the Station.
September	Bulletin No. 2	Cutting Seed Potatoes for Planting.
December	Bulletin No. 3	Fodder Corn and Fodder Cane.
	Annual Report	First Annual Report, 1888.
1889.		
March	Bulletin No. 4	Experiment Orchards.
June	Bulletin No. 5	Horticultural Department and Field Experiments.
	Special Bulletin	Facts about the Station.
September	Bulletin No. 6	Commercial Fertilizers.
December	Bulletin No. 7	Farm Manures.
	Annual Report	Second Annual Report, 1889.
1890.		
March	Bulletin No. 8	Some Feeding Trials.
June	Bulletin No. 9	Strawberries; Variety Comparisons, etc., in 1890.
July	Special Bulletin	Potash and Paying Crops.
September	Bulletin No. 10	Wheat; Effects of Different Fertilizers, etc.
October	Special Bulletin	Composition of Commercial Fertilizers Sold in the State.
December	Bulletin No. 11	Tomatoes in 1890.
	Annual Report	Third Annual Report, 1890.
1891.		
February	Special Bulletin	Composition of Commercial Fertilizers Sold in the State.
March	Bulletin No. 12	Pig Feeding.
June	Bulletin No. 13	Strawberries, Season of 1891.
August	Special Bulletin	Composition of Commercial Fertilizers Sold in the State.
September	Bulletin No. 14	Wheat, Season of 1891.
December	Bulletin No. 15	The Experiment Vineyard.
	Annual Report	Fourth Annual Report, 1891.

MASSACHUSETTS STATE STATION.

1883.		
July	Bulletin No. 1	Organization; Fodder Analyses.
August	Bulletin No. 2	Fertilizer Analyses.
Sept.-Dec.	Bulletins Nos. 3-6	Fodder Analyses; Fertilizer Analyses.
	Annual Report	First Annual Report, 1883.
1884.		
March	Bulletin No. 7	Observations in Regard to Insects Injurious to the Apple; Special Fertilizers in Fruit Culture; Experiments with Currants; Garden Crops; Fertilizer Analyses.
April	Bulletin No. 8	Fodder and Fodder Analyses; Valuation and Analyses of Fertilizers.
May	Bulletin No. 9	Notes upon Insects Injurious to Farm and Garden Crops; Fodder and Fodder Analyses.
June	Bulletin No. 10	Observations Regarding the Vitality of the Seed of Various Weeds, and the Causes of Certain Diseases of Grasses; Feeding Experiments with Corn Ensilage; Fodder and Fodder Analyses.
September	Bulletin No. 11	Notes on Feeding Experiments with Corn Ensilage Continued; Fertilizer Analyses.
October	Bulletin No. 12	Notes on Feeding Experiments with Gluten Meal as a Constituent of Daily Diet of Milch Cows; Fodder and Fodder Analyses.
November	Bulletin No. 13	Notes on Feeding Experiments with Pigs; Fertilizer Analyses.
	Annual Report	Second Annual Report, 1884.
1885.		
March	Bulletin No. 14	Fodder and Fodder Analyses; Valuation and Analyses of Fertilizers.
April	Bulletin No. 15	Notes on Feeding Experiments with Milch Cows; Fertilizer Analyses.
July	Bulletin No. 16	Fodder Analyses; Analyses of Garden Crops; Fertilizer Analyses.
August	Bulletin No. 17	Fodder Analyses; Analyses of Fruits; Analyses of Weeds; Fertilizer Analyses.
October	Bulletin No. 18	Notes on Feeding Experiments with Pigs; Fodder Analyses; Fertilizer Analyses.
	Annual Report	Third Annual Report, 1885.
1886.		
April	Bulletin No. 19	Valuation of Fertilizers and Fertilizer Analyses; Analyses of Articles of Feed with reference to Fertilizing Constituents.
May	Bulletin No. 20	Fodder and Fodder Analyses; Fertilizing Constituents of Feed.
June	Bulletin No. 21	Fodder, Corn, and Corn Ensilage; Fertilizers.
October	Bulletin No. 22	Feeding Experiments with Milch Cows; Fodder and Fodder Analyses.
	Annual Report	Fourth Annual Report, 1886.
1887.		
March	Bulletin No. 23	Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals; Fodder and Fodder Analyses.
April	Bulletin No. 24	Suggestions upon Planting Trees and Small Fruits; Analyses of Fertilizing Material; Fodder and Fodder Analyses.
July	Bulletin No. 25	Notes on Feeding Experiments with Pigs.
August	Bulletin No. 26	Food and Fodder Analyses; Fertilizer Analyses.

List of station publications issued prior to January 1, 1892—**Continued.**

MASSACHUSETTS STATE STATION—Continued.

Date.	Publication.	Title.
1887.		
October....	Bulletin No. 27..	Notes on Feeding Experiments with Milch Cows.
	Annual Report .	Fifth Annual Report, 1887.
1888.		
March	Bulletin No. 28..	[Fertilizer and Fodder Analyses].
June.......	Bulletin No. 29..	[Analyses of Feed Stuffs].
August ...	Bulletin No. 30..	Notes on Feeding Experiments with Pigs.
October....	Bulletin No. 31..	On Commercial Fertilizers; Analyses of Commercial Fertilizers and Manurial Substances.
Aug., Nov .	Circulars	Analyses of Fertilizers.
	Annual Report .	Sixth Annual Report, 1888.
1889.		
February ..	Bulletin No. 32..	[Experiments to Ascertain the Cost of Food for Production of Milk; Analyses of Fodder Articles].
March	Bulletin No. 33..	On Commercial Fertilizers.
June	Bulletin No. 34..	[Outlines of Work for Present Season].
November .	Bulletin No. 35..	Feeding Experiments with Milch Cows.
Apr., May, July, Aug., and Sept.	Circulars	Analyses of Commercial Fertilizers.
	Annual Report .	Seventh Annual Report, 1889.
1890.		
March	Bulletin No. 36..	Meteorological Summary; Some Suggestions on the Economical Improvement of Farm Lands; Analyses of Corn Ensilage and Commercial Fertilizers.
May, June.	Circulars	Analyses of Fertilizers.
July	Bulletin No. 37..	Feeding Experiments with Lambs; Analyses of Feeding Stuffs and Fertilizers.
September.	Bulletin No. 38..	Feeding Experiments with Milch Cows.
Aug., Nov.	Circulars	Analyses of Fertilizers.
	Annual Report .	Eighth Annual Report, 1890.
1891.		
April......	Bulletin No. 39..	Treatment of Fungous Diseases.
Mar., Apr.	Circulars	Analyses of Fertilizers.
July.......	Bulletin No. 40..	[Some Diseases of Lettuce and Cucumbers; Fertilizers; Feeding Experiments with Steers; Weather Record from April to June].
September.	Bulletin No. 41..	Fertilizers; Feeding Experiments with Milch Cows; Weather Record for July and August.
	Annual Report..	Ninth Annual Report, 1891.

MASSACHUSETTS HATCH STATION.

1888.		
July	Bulletin No. 1 ..	Reports of Departments.
October ...	Bulletin No. 2	Reports of Departments.
	Annual Report	First Annual Report, 1888.
1889.		
January ...	Bulletin No. 3 ..	Tuberculosis.
April	Bulletin No. 4 ..	[Report of Division of Horticulture].
July	Bulletin No 5 ..	Household Pests.
October	Bulletin No. 6	Greenhouse Heating; Vegetable Pathology.
November.	Special Bulletin	A Dangerous Insect Pest in Medford; The Gypsy Moth.
Jan.-Dec...	Meteo. Bulletins	Meteorological Bulletins Nos. 1-12.
	Annual Report .	Second Annual Report, 1889.
1890.		
January ...	Bulletin No. 7 ..	Small Fruits and Vegetables; Japanese Crops; Gypsy Moth.
April	Bulletin No. 8 ..	Greenhouse Heating—Steam *vs* Hot Water; Observations on Peach Yellows; How far may a Cow be Tuberculous before her Milk becomes Dangerous as an Article of Food?
May	Bulletin No. 9 ..	Soil Tests with Fertilizers.
May	Special Bulletin	The Most Profitable Use of Commercial Manures.
October	Bulletin No. 10..	Special Fertilizers for Greenhouse Crops; Injury to Peach Buds; Small Fruits.
Jan.-Dec..	Meteo. Bulletins	Meteorological Bulletins Nos. 13-24.
	Annual Report..	Third Annual Report, 1890.
1891.		
January ...	Bulletin No. 11..	Conditions Affecting the Strength of the Stomach of the Calf for Rennet; Treatment of Potatoes with Lime for the Prevention of Rot; Fungicides and Insecticides on the Apple, Pear, Plum, and Grape; Report on Hay Caps; Report on Flandres Oats.
April	Bulletin No. 12..	Report on Insects.
April	Bulletin No. 13..	Directions for the Use of Fungicides and Insecticides.
May	Bulletin No. 14..	Fertilizers for Corn.
October..	Bulletin No. 15..	Experiments in Greenhouse Heating; Special Fertilizers for Plants under Glass; Report on Varieties of Strawberries; Report on Varieties of Blackberries and Raspberries.
Jan.-Dec...	Meteo. Bulletins	Meteorological Bulletins Nos. 25-36.
	Annual Report..	Fourth Annual Report, 1891.

List of station publications issued prior to January 1, 1982—Continued.

MICHIGAN STATION.

Date.	Publication.	Title.
1885.		
March	Bulletin No. 1	Amber Cane for Forage.
April	Bulletin No. 2	Seed Testing.
May	Bulletin No. 3	Wheat Isosoma.
June	Bulletin No. 4	Feeding Cattle.
July	Bulletin No. 5	Seed Vitality.
August	Bulletin No. 6	Diseases of Animals.
September	Bulletin No. 7	Notes on Plants.
October	Bulletin No. 8	Wintering Bees.
November	Bulletin No. 9	Marl.
1886.		
January	Bulletin No. 10	A Disease of Horses.
February	Bulletin No. 11	Making a Lawn.
March	Bulletin No. 12	Rural Adornment.
April	Bulletin No. 13	Potato Culture.
May	Bulletin No. 14	Codling Moth and Bark Louse.
June	Bulletin No. 15	Ashes as Manure.
July	Bulletin No. 16	Grasses.
August	Bulletin No. 17	Carpet Beetle.
September	Bulletin No. 18	Varieties of Wheat.
October	Bulletin No. 19	Tomatoes.
November	Bulletin No. 20	Fertilizer Analyses.
December	Bulletin No. 21	Growing Forest Trees.
1887.		
January	Bulletin No. 22	Epizoötic Ophthalmia.
February	Bulletin No. 23	Apples for Market.
March	Bulletin No. 24	Feeding Cattle.
April	Bulletin No. 25	Laminitis.
May	Bulletin No. 26	Codling Moth and Plant Louse.
June	Bulletin No. 27	Fertilizer Analyses.
September	Bulletin No. 28	Botanical Museum.
October	Bulletin No. 29	Maladie du Coit.
November	Bulletin No. 30	Feeding Cattle.
December	Bulletin No. 31	Annual Report; Report on Tomatoes, and Other Horticultural Work.
1888.		
January	Bulletin No. 32	Forestry Convention.
February	Bulletin No. 33	Arbor Day.
March	Bulletin No. 34	[Potatoes and Oats].
April	Bulletin No. 35	Weather Service Report.
May	Bulletin No. 36	Spaying Cattle.
June	Bulletin No. 37	Jack Pine Plains.
August	Bulletin No. 38	[Experiments with Wheat and Fertilizers].
September	Bulletin No. 39	[Insecticides.]
October	Bulletin No. 40	Horticultural Report.
October	Bulletin No. 41	Warming Water for Dairy Cows.
November	Bulletin No. 42	Oxygen Treatment for Horses.
	Annual Report	Annual Report for 1887–88.
1889.		
January	Bulletin No. 43	Report Weather Service Department.
January	Bulletin No. 44	Feeding Steers of Different Breeds.
March	Bulletin No. 45	Why not Plant a Grove?
March	Bulletin No. 46	Potatoes, Roots, Fertilizers, and Oats.
April	Bulletin No. 47	Silos and Ensilage.
April	Bulletin No. 48	Horticultural Department.
May	Bulletin No. 49	Chemical Composition of Cornstalks, Hay, and Screenings.
June	Bulletin No. 50	The Grain Plant Louse.
July	Bulletin No. 51	Enemies of the Wheat Aphis.
July	Bulletin No. 52	Commercial Fertilizers.
August	Bulletin No. 53	Spraying with the Arsenites.
October	Bulletin No. 54	Experiments and Observations on the Jack Pine Plains.
December	Bulletin No. 55	Fruit Testing.
	Annual Report	Second Annual Report, 1888–89.
1890.		
February	Bulletin No. 56	Rib Grass or Narrow-Leaved Plantain.
March	Bulletin No. 57	Vegetables, Tests of Varieties and Methods of Culture.
March	Bulletin No. 58	Insecticides.
April	Bulletin No. 59	List of Fruits for Michigan; Apple Scab.
April	Bulletin No. 60	Feeding Pigs of Different Breeds; Tests of Varieties of Vegetables.
April	Bulletin No. 61	Foul Brood.
May	Bulletin No. 62	The English Sparrow.
July	Bulletin No. 63	Greenhouse Construction and Heating.
July	Bulletin No. 64	Fertilizer Analyses.
August	Bulletin No. 65	Special Planting for Honey.
September	Bulletin No. 66	Fighting the Plum Curculio.
October	Bulletin No. 67	Fruit Testing at the South Haven Substation.
October	Bulletin No. 68	The Jack Pine Plains; Silage, Milk, and Fertilizer Analyses.
November	Bulletin No. 69	Feeding Steers of Different Breeds.
1891.		
January	Bulletin No. 70	Vegetables, Varieties and Methods of Culture.
February	Bulletin No. 71	Sugar Beets.
February	Bulletin No. 72	Six Worst Weeds.

List of station publications issued prior to January 1, 1892—Continued.

MICHIGAN STATION—Continued.

Date.	Publication.	Title.
1891.		
April	Bulletin No. 73	Kerosene Emulsion; Some New Insects.
May	Bulletin No. 74	Foot Rot in Sheep.
July	Bulletin No. 75	Fertilizer Analyses.
October	Bulletin No. 76	Kerosene Emulsion.
November	Bulletin No. 77	Comparing the Yield of Old Meadows with those Recently Seeded.
December	Bulletin No. 78	Glanders and Farcy.

MINNESOTA STATION.

1886.	Annual Report	Supplement to Report of Board of Regents of the University of Minnesota.
1888.		
January	Bulletin No. 1	Reports on Russian Apples; Wheat Experiments and Potato Culture.
April	Bulletin No. 2	Silos and Ensilage; Tests of Varieties of Corn for Feeding Values; Examination of Beets and other Roots for Sugar and Feeding Values.
July	Bulletin No. 3	Our Russian Apples at the Opening of their Fourth Season; Natural and Artificial Fertilization of Plants; Report on Rocky Mountain Locusts.
October	Bulletin No. 4	Comparative Value of Cold and Warm Water for Stock in Food Consumed and in the Production of Milk, Butter, and Beef; Fungi which Kill Insects; Tuberculosis or Consumption in Domestic Animals.
	Biennial Report	Supplement to Report of Board of Regents of the University of Minnesota.
1889.		
January	Bulletin No. 5	[Reports of the Divisions of Agriculture, Horticulture, Botany].
February	Bulletin No. 6	Experiments with Frosted, Rusted, and Stack-Burned Wheat.
April	Bulletin No. 7	Soil Temperatures; Comparison of Varieties of Corn for Ensilage; Reports on Horticulture, Chemistry, and Veterinary Science.
July	Bulletin No. 8	Siloing Clover; Manures; Wheat; Locusts.
November	Bulletin No. 9	Russian Willows and Poplars.
1890.		
March	Bulletin No. 10	Onions on Land Plowed and Unplowed; Cabbages; London Purple for Curculio on Native Plums; Bagging Grapes; Rollingstone Plum; Potatoes at Different Depths; Oak Caterpillars.
June	Bulletin No. 11	Corn Experiments; Peas, Beans, Flax, and Other Crops; Results of Seeding Rusted, Frosted, and Frozen Wheat of 1888.
July	Bulletin No. 12	Meadows and Pastures in Minnesota; Preserving Vegetables in Carbonic Acid Gas; American-Grown Cauliflower Seed; Protection from Frost.
December	Bulletin No. 13	A Treatise on Flax Culture.
	Biennial Report	Biennial Report, 1889 and 1890.
1891.		
January	Bulletin No. 14	Pig Feeding for Profit; Sugar Beets.
February	Bulletin No. 15	Wheat Experiments.
April	Bulletin No. 16	Sheep Scab and How to Cure it.
August	Bulletin No. 17	Migratory Locusts in Minnesota in 1891.
September	Bulletin No. 18	Notes on Strawberries and Raspberries, 1891; Notes on Sand Cherries, Buffalo Berry and Russian Mulberry; Evergreens from Seed; Summer Propagation of Hardy Plants.

MISSISSIPPI STATION.

1888.		
March	Bulletin No. 1	Organization.
May	Bulletin No. 2	Cotton Worm.
June	Bulletin No. 3	Analyses of Commercial Fertilizers.
November	Bulletin No. 4	The Marls of Mississippi.
	Annual Report	First Annual Report, 1888.
1889.		
May	Bulletin No. 5	Fertilizers.
June	Bulletin No. 6	Charbon.
June	Bulletin No. 7	Hay Presses.
August	Bulletin No. 8	Stock Feeding.
August	Bulletin No. 9	Diseases of Sheep and Calves; Bitterweed.
October	Bulletin No. 10	Dishorning.
	Annual Report	Second Annual Report, 1889.
1890.		
February	Bulletin No. 11	Charbon.
June	Bulletin No. 12	Cotton Leaf Worm.
September	Bulletin No. 13	Feeding for Milk and Butter.
	Annual Report	Third Annual Report, 1890.
1891.		
March	Bulletin No. 14	Injurious Insects.
June	Bulletin No. 15	Feeding; Milk Testing Apparatus.
September	Bulletin No. 16	Glanders.
December	Bulletin No. 17	Insects Injurious to Stored Grain.
	Annual Report	Fourth Annual Report, 1891.

List of station publications issued prior to January 1, 1892—Continued.

MISSOURI STATION.*

Date.	Publication.	Title.
1883.		
January ...	Bulletin No. 1...	Experiment with Pigs.
April	Bulletin No. 2...	Feeding Steers.
	Bulletin No. 3...	Report of Test of Varieties of Wheat and Corn.
October	Bulletin No. 4...	Mulching.
November .	Bulletin No. 5...	Relation of Tillage to Soil Moisture.
December..	Bulletin No. 6...	Relation of Dew to Soil Moisture.
1884.		
February ..	Bulletin No. 7...	Feeding Wheat and Corn.
March......	Bulletin No. 8...	Meal-Feeding Stock at Pasture.
May	Bulletin No. 9...	Grass-Fed Pigs.
July.......	Bulletin No. 10..	Pig Feeding Experiments.
August	Bulletin No. 11..	Value of Corn Fodder as Stock Food.
October....	Bulletin No. 12..	Seed Potatoes.
December..	Bulletin No. 13..	Good Roads and Broad Wheel Tires.
1885.		
February ..	Bulletin No. 14..	Feeding for Lean Meat.
April	Bulletin No. 15..	Contagious Pleuro-Pneumonia.
June.......	Bulletin No. 16..	Report of State Veterinarian on Animal Diseases.
September .	Bulletin No. 17..	General Observations; Grasses and Forage Crops.
November .	Bulletin No. 18..	Subsoiling.
1886.		
January ...	Bulletin No. 19..	Feeding for Lean Meat.
March	Bulletin No. 20..	Observations in Horticultural Department; Small Fruits and Vegetables.
May	Bulletin No. 21..	Plants and their Uses.
July	Bulletin No. 22..	Corn Harvesting—Seasonable Suggestions.
August	Bulletin No. 23..	Relation of Dew to Soil Moisture.
October....	Bulletin No. 24..	Contagious Diseases and their Prevention.
December..	Bulletin No. 25..	Shrinkage of Hay in Stacks; Corn, How to Plant; Test of Varieties.
1887.		
February ..	Bulletin No. 26..	Fruits and Vegetables; Variety Tests.
February ..	Bulletin No. 27..	Calf Feeding Experiments.
June.......	Bulletin No. 28..	Maintenance Rations for Pigs.
August	Bulletin No. 29..	Rotation of Crops.
October....	Bulletin No. 30..	Fertilization.
	Bulletin No. 31..	Texas Fever and other Diseases.
1888.		
January ...	Bulletin No. 32..	Plows and Plowing.
April	Bulletin No. 33..	Glanders, Mad Itch of Cattle, etc.
June.......	Bulletin No. 34..	Experimental Farming.
June.......	Bulletin No. 35..	Grasses for Pastures and for Meadows.
1888.		
March	Bulletin No. 1...	Organization of Station.
	Bulletin No. 2...	Grasses for Pastures and Meadows.
	Bulletin No. 3...	Spaying.
December..	Bulletin No. 4...	A Test of Tillage Implements.
	Annual Report .	First Annual Report, 1888.
1889.		
February ..	Bulletin No. 5...	Soil; Weather; Field Trials with Corn.
	Bulletin No. 6...	Experiments on Seed Germination, Pea Weevil, and Apples.
	Bulletin No. 7...	Experiments, Green *vs.* Dry Storage of Fodder.
	Bulletin No. 8...	Experiments. Feeding Ensilage *vs.* Dry Fodder.
December..	Bulletin No. 9...	Study of the Life History of Corn at its Different Periods of Growth.
1890.		
April	Bulletin No. 10..	Report of Department of Horticulture.
May	Bulletin No. 11..	Texas Fever.
June	Bulletin No. 12..	Blackleg.
1891.		
January . .	Bulletin No. 13..	Report of Department of Horticulture.
April	Bulletin No. 14..	Field Experiments with Corn.
July.......	Bulletin No 15..	Test of Varieties of Wheat and Oats; Change of Seed Wheat, Oats, and Potatoes.
November .	Bulletin No. 16..	Winter Protection of Fruit Trees; Spread of Pear Blight; Meteorological Observations; Experiments with Strawberries, Potatoes, and Seedling Fruits.

NEBRASKA STATION.

1887.		
October	Bulletin No. 1...	Irrigation in Nebraska.
October	Bulletin No. 2...	Twenty-Two Common Insects of Nebraska.
	Annual Report .	First Annual Report, 1887.

* The first thirty-five bulletins in this list were issued as publications of the Missouri Agricultural College, University of the State of Missouri. Bulletin No. 35 of this series is the same as Station Bulletin No. 2.

List of station publications issued prior to January 1, 1892—**Continued.**

NEBRASKA STATION—Continued.

Date.	Publication.	Title.
1888.		
March	Bulletin No. 3...	Southern Cattle Plague and Yellow Fever, from the Etiological and Prophylactic Standpoints.
June.......	Bulletin No. 4...	Swine Plague, its Causes, Nature, and Prevention.
	Annual Report .	Second Annual Report, 1888.
1889.		
January ...	Bulletin No. 5...	Some Injurious Insects of the Year 1888.
March	Bulletin No. 6...	Report of Progress, including a History of the Fields and Description of the Animals Available for Experimentation; Field Experiments and Observations; Meteorological Record.
June.......	Bulletin No. 7, 8, 9, 10.	Original Investigations of Cattle Diseases in Nebraska.
December..	Bulletin No. 11..	The Smut of Wheat and Oats; the Smut of Indian Corn; a Preliminary Enumeration of the Rusts and Smuts of Nebraska; Notes on the Fungi of Economic Interest Observed in Lancaster County, Nebraska, during the Summer of 1889, Observations on the Cottonwood.
	Annual Report .	Third Annual Report.
1890.		
February ..	Bulletin No. 12..	Field Experiments for 1889.
April	Bulletin No. 13..	Experiments in the Culture of the Sugar Beet in Nebraska.
June.......	Bulletin No. 14..	Insects Injurious to Young Trees on Tree Claims.
September .	Bulletin No. 15..	Meteorological Report; Soil Temperatures; Farm Notes.
	Annual Report .	Fourth Annual Report, 1890.
1891.		
April	Bulletin No. 16.	Experiments in the Culture of the Sugar Beet in Nebraska.
June.......	Bulletin No. 17..	Field Experiments and Observations.
December..	Bulletin No. 18..	Preliminary Report on the Native Trees and Shrubs of Nebraska.
	Bulletin No. 19..	Farm Notes for 1891.
	Bulletin No. 20.	Meteorological Observations for 1891.
	Annual Report .	Fifth Annual Report, 1891.

NEVADA STATION.

1888.		
June.......	Bulletin No. 1..	History, Organization, and Proposed Work of the Station.
September .	Bulletin No. 2...	The Investigation of the Interdependence of Plant Life and Climatic Conditions of Nevada.
December..	Bulletin No. 3.	Meteorological Report for 1888.
	Annual Report .	First Annual Report, 1888.
1889.		
March	Bulletin No. 4..	Meteorological Report for January, February, and March.
June.......	Bulletin No. 5...	Meteorological Report for April, May, and June.
September .	Bulletin No. 6...	Meteorological Report for July, August, and September.
December..	Bulletin No. 7...	Meteorological Report for October, November, and December.
	Annual Report .	Second Annual Report, 1889.
1890.		
January ...	Bulletin No. 8...	The Codling Moth.
May	Bulletin No. 9...	A Serious Rose Pest.
July	Bulletin No. 10..	The Pear and Cherry Slug.
September .	Bulletin No. 11.	Plant Lice Infesting the Apple.
	Annual Report .	Third Annual Report, 1890.
1891.		
April	Bulletin No. 12..	Sugar Beet Culture.
October....	Bulletin No. 13..	Sugar Beet Experiments.
December..	Bulletin No. 14..	Potato Experiments.
	Annual Report .	Fourth Annual Report, 1891.

NEW HAMPSHIRE STATION.

1888.		
April	Bulletin No. 1...	Ensilage.
June.......	Bulletin No. 2...	Feeding Experiments.
July	Bulletin No. 3...	When to Cut Corn for Ensilage.
November .	Bulletin No. 4...	The Science and Practice of Stock Feeding.
	Annual Report .	First Annual Report, 1888.
1889.		
March	Bulletin No. 5...	Fertilizers and Fertilizing Materials.
April	Bulletin No. 6...	Experiments with Fertilizers.
May	Bulletin No. 7...	Test of Dairy Apparatus.
November .	Bulletin No. 8...	Feeding Experiments
	Annual Report .	Second Annual Report, 1889.
1890.		
February ..	Bulletin No. 9...	Effect of Food upon milk.
March.....	Bulletin No. 10..	Coöperative Fertilizer Experiments.

List of station publications issued prior to January 1, 1892—Continued.

NEW HAMPSHIRE STATION—Continued.

Date.	Publication.	Title.
1890.		
November .	Bulletin No. 11..	Results of Feeding Skim Milk and Corn Meal *vs.* Corn Meal and Middlings; Determination of the Digestibility of Rations.
1891.		
March	Bulletin No. 12..	Fertilizer Experiments.
May	Bulletin No. 13..	Effect of Food on the Hardness of Butter; Effect of Food on the Quantity of Milk.
May	Bulletin No. 14..	Ensilage in Dairy Farming.
December..	Bulletin No. 15..	Patent Cattle Foods.

NEW JERSEY STATIONS.*

Date.	Publication.	Title.
1880.		
May	Bulletin No. 1...	Suggestions in Regard to the Cranberry Rot and its Cure.
May	Bulletin No. 2...	Raspberry Disease and Suggestions for Overcoming it.
	Bulletin No. 3...	Analyses of Land Plaster.
July	Bulletin No. 4...	Analyses of Guanos, Superphosphates, and Special Manures.
August	Bulletin No. 5...	Analyses of Bone Dust.
August	Bulletin No. 6...	Analyses of Fertilizers.
August	Bulletin No. 7...	Analyses of Fertilizers.
September .	Bulletin No. 8...	Analyses of Fertilizers.
October	Bulletin No. 9...	Analyses of Fertilizers.
	Annual Report .	First Annual Report, 1880.
1881.		
January ...	Bulletin No. 10..	Rational System of Feeding Milch Cows.
March	Bulletin No. 11..	Ensilage.
March	Bulletin No. 12..	Valuation of Fertilizers.
May	Bulletin No. 13..	Land Plaster and Ground Bone.
May	Bulletin No. 14..	Clover Seed Midge.
July	Bulletin No. 15..	Commercial Fertilizers, their Composition and Valuations.
September .	Bulletin No. 16..	Commercial Fertilizers.
November .	Bulletin No. 17..	Commercial Fertilizers.
December..	Bulletin No. 18..	Sorghum Sugar Cane.
	Annual Report .	Second Annual Report, 1881.
1882.		
February ..	Bulletin No. 19..	Green Fodder Corn; Dried Fodder Corn; Ensilage.
March	Bulletin No. 20..	Valuation of Fertilizers.
	Spec. Bulletin A.	Yellow Tobacco.
July	Bulletin No. 21..	Chemical Fertilizers (Incomplete).
July	Bulletin No. 22	Chemical Fertilizers (Complete and Incomplete).
October	Bulletin No. 23..	Commercial Fertilizers.
November .	Bulletin No. 24..	Sorghum; Feeding Experiments with Sorghum Seed.
December .	Bulletin No. 25..	Sorghum and Sugar, Experiments and Investigations of 1882.
	Annual Report .	Third Annual Report, 1882.
1883.		
January ...	Bulletin No. 26..	Field Experiments.
April	Bulletin No. 27..	Prices of Nitrogen, Phosphoric Acid, and Potash, and Analyses of Incomplete Fertilizers.
July	Bulletin No. 28..	Analyses and Valuations of Complete Manures and Special Fertilizers.
August ...	Bulletin No. 29..	Analyses and Valuations of Nitrogenous Superphosphates, Ground Bones, Plain Superphosphates, Poudrettes, and Miscellaneous Fertilizers.
November .	Bulletin No. 30..	Results of Field and Laboratory Experiments with Sorghum for the Season of 1883.
December .	Bulletin No. 31..	Nitrate of Soda or Chili Saltpeter as a Top-Dressing for Wheat.
	Annual Report .	Fourth Annual Report, 1883.
1884.		
March	Bulletin No. 32..	Prices of Nitrogen, Phosphoric Acid, and Potash.
August	Bulletin No. 33..	Analyses and Valuations of Complete Fertilizers.
September .	Bulletin No. 34..	Analyses and Valuations of Incomplete Fertilizers.
	Annual Report .	Fifth Annual Report, 1884.
1885.		
July	Bulletin No. 35..	Meaning of Stations' Valuations, Schedule of Trade Values for 1885, Chemical Composition, Retail Prices, and Guarantied Analyses of Fertilizer Supplies.
October	Bulletin No. 36..	Analyses and Valuations of Complete Fertilizers.
December .	Bulletin No. 37..	Miscellaneous Fertilizers.
December .	Bulletin No. 38..	The Rio Grande Sorghum Sugar Works.
	Annual Report .	Sixth Annual Report, 1885.
1886.		
March	Bulletin No. 39..	Meaning of Stations' Valuations; Schedule of Trade Values for 1886.
October	Bulletin No. 40..	Analyses and Valuations of Complete Fertilizers.
	Annual Report .	Seventh Annual Report, 1886.
1887.		
January ...	Bulletin No. 41..	The Extraction of Sugar from Sorghum at Rio Grande, Cape May County, New Jersey.

*The publications for the years 1880 to 1887, inclusive, were issued by the New Jersey State Experiment Station.

List of station publications issued prior to January 1, 1892—**Continued.**

NEW JERSEY STATIONS—Continued.

Date.	Publication.	Title.
1887.		
April	Spec. Bulletin B.	Alfalfa or Lucern.
September	Bulletin No. 42	Analyses and Valuations of Complete Fertilizers.
December	Bulletin No. 43	Analyses and Valuations of Complete Fertilizers, Ground Bones, and Miscellaneous Material.
	Annual Report	Eighth Annual Report, 1887.
1888.		
March	Bulletin No. 44	Sorghum and Sugar Making; A Report upon Experiments made at Rio Grande during the Season of 1887.
March	Bulletin No. 45	Prices of Nitrogen, Phosphoric Acid, and Potash.
May	Bulletin No. 46	Insect Pests and the Means for Destroying them.
June	Bulletin No. 47	Analyses and Valuations of Incomplete Fertilizers.
August	Bulletin No. 48	Analyses and Valuations of Complete Fertilizers.
November	Bulletin No. 49	Analyses and Valuations of Complete Fertilizers, Ground Bone, and Miscellaneous Samples of Other Fertilizing Materials.
December	Bulletin No. 50	Insects Injurious to the Cabbage, and the Best Means of Preventing their Ravages.
December	Bulletin No. 51	Sorghum and Sugar Making; A Report upon Experiments made at Rio Grande during the Season of 1888.
	Annual Report	Ninth Annual Report of the State Station; First of the College Station.
1889.		
March	Bulletin No. 52	What are the Worst Weeds of New Jersey?
March	Bulletin No. 53	Prices of Nitrogen, Phosphoric Acid, and Potash.
March	Bulletin No. 54	Potash as a Fertilizer.
March	Bulletin No. 55	Entomological Suggestions and Inquiries.
April	Spec. Bulletin C.	Pollen *vs.* Rain.
April	Spec. Bulletin D	Memoranda about Cranberry Insects.
April	Spec. Bulletin E.	Oyster Interests of New Jersey.
July	Bulletin No. 56	Analyses and Valuations of Complete Fertilizers.
July	Bulletin No. 57	Experiments with Different Breeds of Dairy Cows.
April	Spec. Bulletin F.	The Horn Fly.
August	Bulletin No. 58	Analyses of Incomplete Fertilizers.
August	Spec. Bulletin G.	The Potato Rot.
August	Spec. Bulletin H.	The Cranberry Scald.
September	Bulletin No. 59	Analyses and Valuations of Complete Fertilizers.
October	Bulletin No. 60	Ground Bones and Miscellaneous Samples.
October	Bulletin No. 61	Experiments with Different Breeds of Dairy Cows.
October	Spec. Bulletin I	Questions Relative to General Farm Practice.
November	Bulletin No. 62	The Horn Fly.
November	Spec. Bulletin J.	The Sweet Potato Rot.
December	Bulletin No. 63	Experiments on Tomatoes.
December	Bulletin No. 64	Some Fungous Diseases of the Cranberry.
	Annual Report	Tenth Annual Report of the State Station; Second of the College Station.
1890.		
January	Bulletin No. 65	Experiments with Different Breeds of Dairy Cows.
February	Spec. Bulletin K.	The Insects Injuriously Affecting Cranberries.
March	Bulletin No. 66	Fertilizing Materials.
May	Bulletin No. 67	Note on the Wheat Louse.
April	Bulletin No. 68	Experiments with Different Breeds of Dairy Cows.
April	Spec. Bulletin L.	Observations on the Peach for 1890.
July	Bulletin No. 69	Analyses and Valuations of Complete Fertilizers.
July	Bulletin No. 70	Some Fungous Diseases of the Spinach.
August	Bulletin No. 71	Analyses of Incomplete Fertilizers and the Value of Home Mixtures.
October	Bulletin No. 72	Plant Lice and How to Deal With Them.
October	Bulletin No. 73	Analyses and Valuations of Complete Fertilizers.
October	Bulletin No. 74	Ground Bones and Miscellaneous Samples.
November	Bulletin No. 75	Insecticides and How to Apply Them.
November	Bulletin No. 76	Some Fungous Diseases of the Sweet Potato.
December	Bulletin No. 77	Experiments with Different Breeds of Dairy Cows.
	Annual Report	Eleventh Annual Report of the State Station; Third of the College Station.
1891.		
January	Bulletin No. 78	Destroy the Black Knot of Plum and Cherry.
February	Bulletin No. 79	Experiments with Nitrate of Soda on Tomatoes.
March	Bulletin No. 80	Experiments with Fertilizers on Potatoes; Experiments with Fertilizers on Wheat.
July	Bulletin No. 81	Incomplete Fertilizers and Home Mixtures.
July	Bulletin No. 82	The Rose Chafer.
September	Bulletin No. 83	Analyses and Valuations of Complete Fertilizers.
October	Bulletin No. 84	Ground Bone and Miscellaneous Samples.
December	Bulletin No. 85	Farm Practice and Fertilizers to Control Insect Injury.
November	Spec. Bulletin M	Field Experiments with Soil and Black Rot of Sweet Potatoes.
November	Spec. Bulletin N	Insects Injurious to the Blackberry.
	Annual Report	Twelfth Annual Report of the State Station; Fourth of the College Station.

List of station publications issued prior to January 1, 1892—Continued.

NEW MEXICO STATION.

Date.	Publication.	Title.
1890.		
April......	Bulletin No. 1...	Announcements.
October....	Bulletin No. 2...	Announcements.
	Annual Report .	First Annual Report.
1891.		
June	Bulletin No. 3...	A Preliminary Account of Some Insects Injurious to Fruits.
December .	Bulletin No. 4...	Horticultural Work.
	Annual Report .	Second Annual Report, 1890-91.

NEW YORK STATE STATION.

1882.		
July.......	Bulletin No. 1...	Test of Small Fruits and Vegetables; Culture Experiments with Wheat, Corn, and Potatoes; Description of Lysimeters.
July.......	Bulletin No. 2...	Potato Experiments with Seed Cut Different Sizes.
August....	Bulletin No. 3...	Corn Culture; Root Washing of the Potato; Analyses of Pigweed (*Chenopodium album*).
August....	Bulletin No. 4...	Wheat.
August....	Bulletin No. 5...	Cultivation of the Soil to Retard Evaporation; Tests of Peas, Cabbages, and Tomatoes; Analysis of Redweed (*Amaranthus retroflexus*).
August....	Bulletin No. 6...	Corn, Potatoes, Sorghum, and Cabbage, and Cabbage Worm and Borer.
September.	Bulletin No. 7...	Potatoes, Pacey's Ray Grass, Soja hispida (Japanese Bean), and Analyses of Cowpea.
September.	Bulletin No. 8...	Teosinte, Pearl Millet, Chinese Bean, Cowpeas, Tomato Rot, and Peas.
September.	Bulletin No. 9...	Sorghum; Filling Silo with Corn; Stirring Soil to Retard Evaporation; Cucumbers.
September .	Bulletin No. 10..	Soja Bean, Pasture Grasses, Seed Improvement, Analysis of Tomato, and Sugar in Corn.
September .	Bulletin No. 11..	Oats, Cowpeas, and Weeds.
October....	Bulletin No. 12..	Barley, and Agricultural Museum.
October....	Bulletin No. 13..	Corn, Butt and Tip Kernels of, for Seed and Fertilizer Experiments with Corn.
October....	Bulletin No. 14..	Garden Vegetables, Potatoes, and Corn.
	Bulletin No. 15..	Corn Hybridization.
October....	Bulletin No. 16..	Twenty-Eight Varieties of Cabbage Tested.
November .	Bulletin No. 17..	Fertilizers as Adapted to Plant Growth.
November .	Bulletin No. 18..	Potato Planting.
November .	Bulletin No. 19..	Potato Culture.
December .	Bulletin No. 20..	Clover and Tobacco.
December..	Bulletin No. 21..	Amber Cane.
December..	Bulletin No. 22..	Sugar from Corn.
December..	Bulletin No. 23..	Seed Testing
December..	Bulletin No. 24..	Seed Testing.
	Annual Report .	First Annual Report, 1882.
1883.		
January ...	Bulletin No. 25..	Milk.
January ...	Bulletin No. 26..	Germination of Corn.
January ...	Bulletin No. 27..	Corn.
January ...	Bulletin No. 28..	Potato Experiments.
February ..	Bulletin No. 29..	Germination of Seeds.
February ..	Bulletin No. 30..	Improvement of Varieties.
February ..	Bulletin No. 31..	Planting Corn from Different Parts of the Ear.
February ..	Bulletin No. 32..	Corn Culture.
March	Bulletin No. 33..	Influence of Food on Milk.
March	Bulletin No. 34..	The Feeding of Cows.
March	Bulletin No. 35..	The Feeding of Cows.
March	Bulletin No. 36..	Feeding Experiments with Cows.
March	Bulletin No. 37..	Digestibility of Corn Silage.
April	Bulletin No. 38..	Influence of Seed from Different Parts of Plant.
April	Bulletin No. 39..	Test of Seeds.
April	Bulletin No. 40..	The Weather during the Winter of 1882-83.
April	Bulletin No. 41..	The Cutting of Seed Potatoes.
May	Bulletin No. 42..	Fertilizer Analyses
May	Bulletin No. 43..	Experiments in Cross-Fertilization.
May	Bulletin No. 44..	Variations in Seedling Plants.
May	Bulletin No. 45..	Germination Tests of Varieties of Wheat.
June.......	Bulletin No. 46..	Cross-Fertilization of Corn.
June.......	Bulletin No. 47..	Observations on Corn Plants.
June.......	Bulletin No. 48..	Experiments with Insecticides.
June.......	Bulletin No. 49..	Grass Experiments.
June.......	Bulletin No. 50..	Seed Selection.
July.......	Bulletin No. 51..	Seed Selection.
July.......	Bulletin No. 52..	Peas.
July.......	Bulletin No. 53..	Seed Selection.
July.......	Bulletin No. 54..	Peach Curl.
August....	Bulletin No. 55..	Selection of Varieties of Corn.
August....	Bulletin No. 56..	Soil Analysis.

List of station publications issued prior to January 1, 1892—Continued.

NEW YORK STATE STATION—Continued.

Date.	Publication.	Title.
1883.		
August	Bulletin No. 57	Ash Analysis of the Corn Plant.
August	Bulletin No. 58	Analysis of Plantain and Ox-Eye Daisy.
September	Bulletin No. 59	Variations in Plants.
September	Bulletin No. 60	Races of Corn.
September	Bulletin No. 61	Root-Pruning of Barley.
September	Bulletin No. 62	Seed Tests.
September	Bulletin No. 63	Insecticides.
October	Bulletin No. 64	Potato Seed from Different Parts of the Tuber.
October	Bulletin No. 65	Mulching for Potatoes.
October	Bulletin No. 66	Variations in the Results of Plant Experiments with Potatoes.
November	Bulletin No. 67	The Effect of Planting Corn Along with Other Crops.
November	Bulletin No. 68	Sunflowers.
November	Bulletin No. 69	Experiments with Potatoes.
November	Bulletin No. 70	Analyses of Corn.
November	Bulletin No. 71	Effect of Fertilizers on Tobacco.
November	Bulletin No. 72	Cross-Fertilization of Corn.
November	Bulletin No. 73	Analyses of Corn and Alfalfa.
December	Bulletin No. 74	Corn.
December	Bulletin No. 75	Apple Maggot.
	Annual Report	Second Annual Report, 1883.
1884.		
January	Bulletin No. 76	Maize.
January	Bulletin No. 77	Onions, Strawberries, and Cauliflowers.
January	Bulletin No. 78	Sorghum Analyses.
February	Bulletin No. 79	Coal Ashes.
March	Bulletin No. 80	Influence of Climate upon the Action of Fertilizer in its Relation to Crop.
March	Bulletin No. 81	Celery and Tomatoes.
April	Bulletin No. 82	Corn Analyses.
April	Bulletin No. 83	Varieties of Sweet Corn.
April	Bulletin No. 84	Silage for Cows.
May	Bulletin No. 85	Digestibility of Fodder Corn and the Same Ensilaged.
May	Bulletin No. 86	Corn Cutworms.
July	Bulletin No. 87	Varieties of Peas.
July	Bulletin No. 88	Insecticides for the Turnip Flea Beetle.
July	Bulletin No. 89	Cross-Fertilization of Beans.
July	Bulletin No. 90	Insecticides.
July	Bulletin No. 91	Vegetables.
August	Bulletin No. 92	Pear Blight.
August	Bulletin No. 93	Corn Analyses.
August	Bulletin No. 94	Varieties of Raspberries.
August	Bulletin No. 95	Ripe *vs.* Immature Seed.
September	Bulletin No. 96	List of Station Farm Products Exhibited at the New York State Fair of 1884.
September	Bulletin No. 97	Smut in Oats.
September	Bulletin No. 98	Tomatoes.
September	Bulletin No. 99	Cross-Fertilization of Barley.
October	Bulletin No. 100	An Insect New to the State (*Isosoma tritici*).
October	Bulletin No. 101	The Root Systems of Certain Vegetables.
October	Bulletin No. 102	Varieties of Oats.
November	Bulletin No. 103	Varieties of Flint Corn.
November	Bulletin No. 104	Feeding for Milk.
November	Bulletin No. 105	Varieties of Barley.
November	Bulletin No. 106	Influence of Acid and Putrefactive Food upon Cows and Their Milk; Brewers' Grains.
	Annual Report	Third Annual Report, 1884.
1885.		
January	Bulletin No. 107	Policy of the Station.
January	Bulletin No. 108	Variations in the Yield of Potatoes.
January	Bulletin No. 109	Experiments with Potato Seed.
February	Bulletin No. 110	Influence of Feeding Acid Food to Cows; Corn Feed or Slump.
March	Bulletin No. 111	Causes of the Failure of Corn to Germinate.
April	Bulletin No. 112	Drying Corn for Seed.
April	Bulletin No. 113	By-Products from Glucose and Starch Factories.
April	Bulletin No. 114	Influence of Feeding Acid Food to Cows.
March	Bulletin No. 115	The Absorption of the Seed Tuber of the Potato during Growth of the Plant.
	NEW SERIES.*	
July	Bulletin No. 1	Fertilizers.
August	Bulletin No. 2	Pear Blight.
September	Bulletin No. 3	Descriptive Circular. (For use at State Fair).
September	Bulletin No. 4	Experiments with Oats.
October	Bulletin No. 5	Cooked *vs.* Raw Food for Stock.
November	Bulletin No. 6	Hay *vs.* Damaged Hay.
	Annual Report	Fourth Annual Report, 1885.

* No. 1 of this series is No. 116 of the old series.

List of station publications issued prior to January 1, 1892—Continued.

NEW YORK STATE STATION—Continued.

Date.	Publication.	Title.
1886.		
March	Bulletin No. 7	Slug Shot
April	Bulletin No. 8	Corn.
	Annual Report	Fifth Annual Report, 1886.
1887.		
March	Bulletin No. 9	Was it Poison or Overfeeding?
	Annual Report	Sixth Annual Report, 1887.
1888.		
August	Bulletin No. 10	Influence of Fertilizers on the Chemical Composition of Plants; Analyses of Feeding Stuffs; Feeding and Digestion Experiments.
September	Bulletin No. 11	Experiments in Cultivation; Root Growth; Fertilizers; Insecticides; Fungicides; Potatoes; and Sorghum.
September	Bulletin No. 12	Fertilizer Laws; Statistics of Fertilizers; the Maynard Bill.
September	Bulletin No. 13	Farm and Field Experiments.
October	Bulletin No. 14	Chemical Composition of Some Feeding Stuffs.
November	Bulletin No. 15	Fruits.
	Annual Report	Seventh Annual Report, 1888.
1889.		
July	Bulletin No. 16	A Study of the Corn Plant; Lucern or Alfalfa.
October	Bulletin No. 17	Cattle Foods and Feeding Rations.
November	Bulletin No. 18	Testing of Dairy Breeds.
	Annual Report	Eighth Annual Report, 1889.
1890.		
June	Bulletin No. 19	A Method for the Determination of Fat in Milk and Cream.
June	Bulletin No. 20	Pedigrees of Dairy Animals under Investigation.
July	Bulletin No. 21	Testing of Dairy Breeds.
August	Bulletin No. 22	Pig Feeding Experiments without Milk.
September	Bulletin No. 23	Comparative Test of Cows.
October	Bulletin No. 24	Experiments with Strawberries.
November	Bulletin No. 25	The New York Fertilizer Control and Fertilizer Analyses.
	Annual Report	Ninth Annual Report, 1890.
1891.		
January	Bulletin No. 26	History, Use, and Analyses of Fertilizers.
February	Bulletin No. 27	General Principles Underlying the Use of Fertilizers.
April	Bulletin No. 28	Pig Feeding Experiments with Coarse Foods.
April	Bulletin No. 29	Feeding Experiments with Laying Hens.
May	Bulletin No. 30	Cabbages and Cauliflowers; Imported *vs.* American Seed Tomatoes.
May	Bulletin No. 31	Commercial Valuation of the Food and Fertilizing Constituents of Feeding Materials.
June	Bulletin No. 32	Fertilizers.
July	Bulletin No. 33	The New York State Fertilizer Control and Fertilizer Analyses; Explanation of Forms of Chemical Analysis; Commercial Valuations of Fertilizers; Composition of Various Chemical Compounds.
August	Bulletin No. 34	Comparison of Dairy Breeds of Cattle with Reference to Production of Butter.
August	Bulletin No. 35	Some of the most Common Fungi and Insects with Preventives.
September	Bulletin No. 36	The Strawberry; Insect Enemies of the Strawberry; The Raspberry; Diseases of the Raspberry; Insect Enemies of the Raspberry; The Blackberry; The Currant; Insect Enemies of the Currant; The Gooseberry; Gooseberry Mildew.
November	Bulletin No. 37	Investigation of Cheese; Experiments in the Manufacture of Cheese; Influence of the Composition of Milk on Composition and Yield of Cheese; A Study of the Process of Ripening of Cheese.

NEW YORK CORNELL STATION.

1882–83.	Annual Report	Report of Agricultural Department of Cornell University.
1888.		
May	Bulletin No. 1	Experimental Dairy House.
August	Bulletin No. 2	Comparative Value of Feed Stuffs for Sheep.
November	Bulletin No. 3	The Insectary of Cornell University.
December	Bulletin No. 4	Growing Corn for Fodder and Ensilage.
	Annual Report	First Annual Report, 1888.
1889.		
April	Bulletin No. 5	On the Production of Lean Meat in Mature Animals; Does Heating Milk Affect the Quality or Quantity of Butter?
June	Bulletin No. 6	On the Determination of Hydroscopic Water in Air-Dried Fodders; The Determination of Nitrogen by the Azotometric Treatment of the Solution Resulting from the Kjeldahl Digestion; Fodders and Feeding Stuffs.
July	Bulletin No. 7	On the Influences of Certain Conditions upon the Sprouting of Seeds.
August	Bulletin No. 8	On the Effect of Different Rations on Fattening Lambs.
September	Bulletin No. 9	A Study of Wind-Breaks in their Relations to Fruit Growing.
October	Bulletin No. 10	Tomatoes.
November	Bulletin No. 11	On a Sawfly Borer in Wheat.
December	Bulletin No. 12	A New Apparatus for Drying Substances in Hydrogen and for Extraction of the Fat.

List of station publications issued prior to January 1, 1892—**Continued.**

NEW YORK CORNELL STATION—Continued.

Date.	Publication.	Title.
1889.		
December..	Bulletin No. 13..	On the Deterioration of Farmyard Manure by Leaching and Fermentation; On the Effect of a Grain Ration for Cows at Pasture.
December..	Bulletin No. 14..	On the Strawberry Leaf Blight; on another Disease of the Strawberry.
December..	Bulletin No. 15..	Sundry Investigations Made during the Year.
	Annual Report.	Second Annual Report, 1889.
1890.		
March	Bulletin No. 16..	Growing Corn for Fodder and Silage.
May	Bulletin No. 17..	A Description of Cochran's Method for the Determination of Fat in Milk, for the Use of Dairymen.
July	Bulletin No. 18..	Experience in Spraying Plants.
August....	Bulletin No. 19..	Report on the Condition of Fruit Growing in Western New York.
September.	Bulletin No. 20..	Cream Raising by Dilution.
October....	Bulletin No. 21..	Notes on Tomatoes.
November.	Bulletin No. 22..	On the Effect of a Grain Ration for Cows with Pasturage and with Green Fodder.
December.	Bulletin No. 23..	Insects Injurious to Fruits.
December..	Bulletin No. 24..	The Clover Rust.
December..	Bulletin No. 25..	Milk; Miscellaneous Analyses.
	Annual Report.	Third Annual Report, 1890.
1891.		
March	Bulletin No. 26..	Notes on Eggplants.
May	Bulletin No. 27..	The Production and Care of Farm Manures.
June.......	Bulletin No. 28..	Experiments in the Forcing of Tomatoes.
July	Bulletin No. 29..	Cream Raising by Dilution; The Effect of a Delay in Setting on the Efficiency of Creaming; Application of Dr. Babcock's Centrifugal Method to the Analyses of Milk, Skim Milk, Buttermilk, and Butter; The Relation of Fibrin to the Effectual Creaming of Milk.
August....	Bulletin No. 30..	Some Preliminary Studies of the Influence of the Electric Arc Lamp upon Greenhouse Plants.
September.	Bulletin No. 31..	The Forcing of English Cucumbers.
October....	Bulletin No. 32..	Tomatoes.
November.	Bulletin No. 33..	Wireworms.
November.	Bulletin No. 34..	Dewberries.
December..	Bulletin No. 35..	Combinations of Fungicides and Insecticides, and Some New Fungicides.
December..	Bulletin No. 36..	The Effect of a Grain Ration for Cows at Pasture.
December..	Bulletin No. 37..	Sundry Investigations Made during the Year.
	Annual Report.	Fourth Annual Report, 1891.

NORTH CAROLINA STATION.

1878.		
	....	Directions for Making Vinegar.
	....	Analyses and Valuations of Fertilizers for 1877-78 (republished in 1879).
	....	Ville's Formulas for Composting, and Others Furnished by Dr. Ledoux.
	....	The Sugar Beet in North Carolina.
	....	Silica *vs.* Ammonia; Results of Comparative Soil Tests of Popplein's Silicated Phosphate with a Number of Ammoniated Guanos.
1879.		
January ...	....	Report of the Director to the Legislature.
	....	Analyses and Valuations of Fertilizers.
	....	Formulas for Composting.
	....	Report of the Station for 1879.
1880.	....	Report of the Station for 1880, including Analyses of Fertilizers for that Year.
1881.		
January ...	....	Report to the Legislature.
January ...	....	Analyses of Drinking Waters.
February ..	....	Value of Active Ingredients of Fertilizers.
March	....	The Use of Agricultural Chemicals.
March	....	Analyses and Valuations of Fertilizers and Chemicals.
July	....	Adulterated Chemicals.
July	....	Analyses and Valuations of Fertilizers, Second Edition.
	Annual Report.	Annual Report, 1881.
1882.		
January ...	....	Extension in Cotton Culture.
February ..	....	High Manuring on Cotton.
March	....	Does Cotton Exhaust? Cotton Seed and its Uses.
April	....	Stable Manure Saved and Composted; Rice Products as a Feeding Stuff.
	....	Analyses of Fertilizers.
	....	Analyses of Fertilizers, Second Edition.
May	....	Rice and its Products; Food and Fodder Plants.
June......	....	Experience with Homemade Manures.

List of station publications issued prior to January 1, 1892—Continued.

NORTH CAROLINA STATION—Continued.

Date.	Publication.	Title.
1882.		
June		Report of Work Done for the State Board of Health.
October		Treatment of Cotton Lands; Station at State Fair.
		Horn, Leather, and Wool Waste, and the Fertilizers Made from Them.
		Finely Ground Phosphates or "Floats."
		On Kainit.
	Annual Report	Annual Report, 1882.
1883.		
May		The Soja Bean; Waste Products of Tobacco Factories.
May		Analyses of Fertilizers.
May		Analyses of Fertilizers, Second Edition.
June		Cotton Seed and its Products.
December		North Carolina Resources for Commercial Fertilizers: Ammoniates; Potash Sources; Phosphates.
	Annual Report	Annual Report, 1883.
1884.		
January		The Trade in Fertilizers during 1883.
February		Cost of the Ingredients of Fertilizers.
March		The Phosphate Investigation.
March		Analyses of Fertilizers, Season of 1884.
April		Composition of North Carolina Phosphates.
April		North Carolina Phosphates, Report on.
April		Analyses of Fertilizers, Season of 1885.
April		Analyses of Fertilizers, Second Edition.
	Annual Report	Annual Report, 1884.
1885.		
		Analyses of Fertilizers, Additional.
		Analyses of Composts.
		Injurious Insects and Diseases of Stock.
		Report of Station.
		Instructions for Voluntary Observers and Displaymen.
1886.		
	Annual Report	Annual Report, 1886.
1887.		
September		Formulas for Composts.
		Report of North Carolina Weather Service for 1887.
		Composts and Ingredients Composing Them.
	Annual Report	Annual Report, 1887.
1888.		
June	Bulletin No. 57	Field Experiments.
July	Bulletin No. 58	Details of Field Experiments; Examination of North Carolina Drinking Waters.
August, September.	Bulletin No. 59	Purity and Vitality of Seed, with Tests of Seed Sold in North Carolina.
Oct., Nov.	Bulletin No. 60	Lucern, its Value as a Forage Crop.
	Annual Report	Annual Report, 1888.
1889.		
January	Bulletin No. 61	Composts: Formulas, Analyses, and Values.
February	Bulletin No. 61½	Fertilizer Analyses; Seed Examination for Planters.
February	Bulletin No. 62	Fertilizer Analyses.
March	Bulletin No. 62½	Fertilizer Analyses and Fertilizer Control.
June	Bulletin No. 63	Tests of Seeds; Rust on Wheat and Cotton; Laboratory Notes.
July	Bulletin No. 64	Practical Stock Feeding on Scientific Principles.
August, September.	Bulletin No. 65	Coöperative Field Tests during 1888.
September	Bulletin No. 66	Stock Feeding as Practiced in North Carolina; Indian Corn.
October	Bulletin No. 67	Seed Tests.
October	Bulletin No. 67*a*	Technical Bulletin No. 1, Seed Tests.
November	Bulletin No. 68	Farm and Dairy Buildings.
November	Bulletin No. 68*a*	Meteorological Data.
December	Bulletin No. 68*b*	Meteorological Data.
	Annual Report	Annual Report, 1889.
1890.		
January	Bulletin No. 68*c*	Meteorological Data.
February	Bulletin No. 69	Fertilizer Analyses and Fertilizer Control.
February	Bulletin No. 69*a*	Meteorological Data.
March	Bulletin No. 69*b*	Meteorological Data.
April	Bulletin No. 70	The Weed Pests of the Farm; Japan Clover, its Value as a Renovator of Worn Soils.
June	Bulletin No. 70*a*	Meteorological Data.
May	Bulletin No. 71	Coöperative Field Tests during 1889; Hillside Ditches.
June	Bulletin No. 72	The Work of The Horticultural Division; The Value of Pea-Vine Manuring for Wheat.
July	Bulletin No. 72*a*	Meteorological Data.
July	Bulletin No. 72*b*	Meteorological Data.
September	Bulletin No. 72*c*	Meteorological Data.
October	Bulletin No. 73	The Best Agricultural Grasses.
October	Bulletin No. 73*a*	Meteorological Summary.
December	Bulletin No. 73*b*	Meteorological Summary; Origin of Cold Waves.

List of station publications issued prior to January 1, 1892—Continued.

NORTH CAROLINA STATION—Continued.

Date.	Publication.	Title.
1890.		
December..	Bulletin No. 74..	Tests of Garden Vegetables and Fruits; Culture of Figs.
December..	Bulletin No. 74*a*.	Meteorological Summary.
	Annual Report .	Annual Report, 1890.
	Meteor. Report .	Annual Report, Meteorological Division, 1890.
1891.		
January ...	Bulletin No. 74*b*.	Meteorological Summary.
April......	Bulletin No. 75..	Fertilizers.
April......	Bulletin No. 75*c*.	Meteorological Summary.
March......	Bulletin No. 76..	Plant Diseases and How to Combat Them.
May	Bulletin No. 77..	Value of Pea-Vine Manuring for Wheat.
July.......	Bulletin No. 77*b*.	Technical Bulletin No. 2, July. The Injury of Foliage by Arsenites; A Cheap Arsenite; Combination of Arsenites with Fungicides.
July.......	Bulletin No. 78..	Some Injurious Insects.
July.......	Bulletin No. 78*a*.	Meteorological Summary.
July.......	Bulletin No. 79..	Facts for Farmers.
August....	Bulletin No. 79*a*.	Meteorological Summary.
October....	Bulletin No. 80..	Silos and Silage.
December..	Bulletin No. 80*a*.	Synopsis of the Published Work of the Entomological and Botanical Divisions of the Station.
September .	Bulletin No. 80*b*.	Meteorological Summary.
October....	Bulletin No. 80*c*.	Technical Bulletin No. 3. The Digestibility of Cotton-Seed Hulls; The Digestibility of a Ration of Cotton-Seed Hulls and Cotton-Seed Meal; Comparison of Composition and Digestibility of Wheat Straw and Cotton-Seed Hulls; The Fertilizing Constituents Recovered in Manure in these Experiments.
October....	Bulletin No. 80*d*.	Meteorological Summary.
November .	Bulletin No. 80*e*.	Meteorological Summary.
December..	Bulletin No. 81..	Feeding Cotton-Seed Hulls and Meal for the Production of Beef.
December..	Bulletin No. 81*a*.	Meteorological Summary.
	Annual Report..	Annual Report, 1891.

NORTH DAKOTA STATION.

	Annual Report..	First Annual Report, 1890.
1891.		
January ...	Bulletin No. 1...	Grain Smuts.
April......	Bulletin No. 2...	Small Fruits.
October....	Bulletin No. 3...	Diseases of Sheep.
December..	Bulletin No. 4...	Potato Scab and Possibilities for Prevention; A Disease of Beets Identical with Deep Scab of Potatoes; Hastening the Maturity of Potatoes.
	Annual Report..	Second Annual Report, 1891.

OHIO STATION.

1882.		
	Annual Report .	First Annual Report.
1883.		
September.	Bulletin No. 1*..	Experiments with Wheat, 1882–83.
	Bulletin No. 12*.	Varieties of Corn.
	Bulletin No. 16*.	Test of Varieties of Wheat.
1883–87	Annual Reports	Second Annual Report, 1883.
	....	Third Annual Report 1884.
	....	Fourth Annual Report, 1885.
	....	Fifth Annual Report, 1886.
	....	Sixth Annual Report, 1887.
	SECOND SERIES.	
1888.		
April......	Bulletin No. 1...	History, Organization, and Work of Station.
	Bulletin No. 2...	Small Fruits and Vegetables.
May	Bulletin No. 3...	The Spring and Summer Treatment of Apple Orchards to Prevent Insect Injuries; Experiments with Remedies for the Plum Curculio.
July.......	Bulletin No. 4...	Experiments in Preventing Curculio Injury to Cherries; The Chinch Bug in Ohio—Midsummer Remedies.
August....	Bulletin No. 5...	Small Fruits.
September .	Bulletin No. 6...	Experiments with Wheat.
December..	Bulletin No. 7...	Corn, Fertilizer Experiments.
	Annual Report .	Seventh Annual Report, 1888.
1889.		
March.....	Bulletin No. 8 (Vol. II, No. 1).	Insects and Insecticides.

* Bulletins in this series were printed in the form of newspaper slips, but were reprinted in the first six annual reports of the station. With the exception of Bulletins Nos. 1, 12, and 16, we are unable to give the titles or dates of the publications.

List of station publications issued prior to January 1, 1892—**Continued.**

OHIO STATION—Continued.

Date.	Publication.	Title.
1889.		
April	Bulletin No. 9 (Vol. II, No. 2).	Colic of Horses.
June	Bulletin No. 10 (Vol. II, No. 3).	Silos and Ensilage; Ensilage *vs.* Field Beets as Food for Cows.
July	Bulletin No. 11 (Vol. II, No. 4).	Experiments with Small Fruits; Effect of Early and Late Picking upon Keeping Quality of Apples.
August	Bulletin No. 12 (Vol. II, No. 5).	Experiments in Wheat Seeding; Comparative Tests of Varieties of Wheat.
September	Bulletin No. 13 (Vol. II, No. 6).	Remedies for the Plum Curculio; Remedies for the Striped Cucumber Beetle; Strawberry Root Louse and Grain Plant Louse; Notes on Little-Known Injurious Insects; Preventing the Injuries of Potato Rot.
October	Bulletin Vol. I, No. 1. (Tech. ser).	Preparatory Stages of the 20-Spotted Ladybird; Studies in Pond Life; A Partial Bibliography of Insects Affecting Clover.
November	Bulletin No. 14 (Vol. II, No. 7).	Cabbage and Cauliflower; Notes on Experiments with Remedies for Certain Diseases of Plants.
	Bulletin No. 15 (Vol. II, No. 8).	Eighth Annual Report, 1889.
1890.		
January	Bulletin Vol. III, No. 1.	Experiments with Potatoes.
February	Bulletin Vol. III, No. 2.	Commercial Fertilizers.
March	Bulletin Vol. III, No. 3.	Experiments with Corn; Experiments with Oats; Actinomycosis.
April	Bulletin Vol. III, No. 4.	Spraying to Prevent Insect Injury; Bark Lice of the Apple and Pear; Buffalo Tree Hopper; Insects Affecting Corn in Southern Ohio; Ox-Warble Fly or Botfly; Fungous Diseases of Plants and their Remedies; Directions for Collecting, Preserving, and Studying Plants.
May	Bulletin Vol. I, No. 2. (Tech. ser).	A Catalogue of the Uncultivated Flowering Plants Growing on the Ohio State University Grounds; Fourth Contribution to a Knowledge of the Life History of Certain Little-Known Plant Lice; A Descriptive Catalogue of the Shells of Franklin County, Ohio.
June	Bulletin Vol. III, No. 5.	Corn Silage *vs.* Sugar Beets as Food for Milk Production.
July	Bulletin Vol. III, No. 6.	Experiments in Wheat Seeding; Comparative Tests of Varieties of Wheat; Smut in Wheat; Results of Experiments with Fertilizers on Wheat.
August	Bulletin Vol. III, No. 7.	Strawberries; Raspberries.
September	Bulletin Vol. III, No. 8.	Plum Curculio Experiments; Remedies for the Striped Cucumber Beetle; The Rhubarb Curculio; The Clover Stem Borer; Potato Blight Experiments.
October	Bulletin Vol. III, No. 9.	Asparagus; Transplanting Onions.
November	Bulletin Vol. III, No. 10.	Experiments in Preventing Downy Mildew or Brown Rot of Grapes; The Smut of Indian Corn.
December	Bulletin Vol. III, No. 11.	Ninth Annual Report, 1890.
1891.		
January	Bulletin Vol. IV, No. 1.	Experiments with Corn.
February	Bulletin Vol. IV, No. 2.	Miscellaneous Experiments in the Control of Injurious Insects.
August	Bulletin Vol. IV, No. 3.	Commercial and Other Fertilizers on Wheat.
August	Bulletin Vol. IV, No. 4.	Experiments in Wheat Seeding, including Treatment of Seed for Smut; Comparative Tests of Varieties of Wheat.
September	Bulletin Vol. IV, No. 5.	The Wheat Midge.
October	Bulletin Vol. IV, No. 6.	Experiments with Small Fruits in 1891; Diseases of the Raspberry and Blackberry.
November	Bulletin Vol. IV, No. 7.	The Hessian Fly.
November	Bulletin Vol. IV, No. 8.	Forty Years of Wheat Culture in Ohio.
December	Bulletin Vol. IV, No. 9.	Experiments in Spraying Orchards for Prevention of the Scab of the Apple and Pear and Other Fungous Diseases, and for the Control of the Plum Curculio.
December	Bulletin Vol. IV, No. 10.	Tenth Annual Repor , 1891.

OKLAHOMA STATION.

1891.		
December	Bulletin No. 1	General Information, Organization, and History.

List of station publications issued prior to January 1, 1892—Continued.

OREGON STATION.

Date.	Publication.	Title.
1888.		
October....	Bulletin No. 1...	History and Organization.
1889.		
January ...	Bulletin No. 2...	Preparation and Notes on Future Horticultural Work.
October....	Bulletin No. 3...	Practical Work with Insecticides; Corn Worm; Spraying Machines; Directions for Sending Insects; Some Investigations on Plants Poisonous to Stock.
	Annual Report..	First Annual Report, 1889.
1890.		
January ...	Bulletin No. 4...	Notes on Farm Crops; Horticultural Notes; Chemical Analyses.
April	Bulletin No. 5...	Entomological Notes; Gophers and Rabbits; Analysis of Bone Meal.
July	Bulletin No. 6...	Examination of Cattle Foods; Economic Zoölogy.
October....	Bulletin No. 7...	Comparative Tests of Small Fruits and Vegetables.
	Annual Report..	Second Annual Report, 1890.
1891.		
January ...	Bulletin No. 8...	Notes on Varieties of Wheat and Flax.
February ..	Bulletin No. 9...	Silos and Ensilage.
April	Bulletin No. 10..	Experiments with Codling Moth and with a Combined Fungicide and Insecticide; Description of Spraying Apparatus; Notes on the Hop Louse.
May	Bulletin No. 11..	Notes on Grasses and Potatoes.
September .	Bulletin No. 12..	Comparative Test of Strawberries for 1891; Meteorological Summary.
October....	Bulletin No. 13..	Mineral and Mineral Water Analyses; Soils and Agricultural Survey.
December..	Bulletin No. 14..	Notes on Insects.

PENNSYLVANIA STATION.*

1869-81.	Annual Reports.	Annual Reports for 1869, 1872, 1879-80, and 1881.
1882.		
November .	Bulletin No. 1...	The Result of an Experiment Showing the Effect of Various Fertilizers on the Quantity and Quality of the Wheat Crop.
December..	Bulletin No. 2...	The Results of Experiments with Various Fertilizers on Corn and Oats; An Examination of Agricultural Seeds.
	Annual Report..	Annual Report, 1882.
1883.		
January ...	Bulletin No. 3...	The Composition, Valuation, and Purchase of Commercial Fertilizers.
May	Bulletin No. 4...	The Use of Commercial Fertilizers.
August....	Bulletin No. 5...	Results of Experiments on the Effect of Cutting Timothy and Clover Grass at Different Stages of Growth.
November .	Bulletin No. 6...	Feeding Experiments.
December .	Bulletin No. 7...	Note on an Experiment with Native Potatoes.
	Annual Report..	Annual Report, 1883.
1884.		
April	Bulletin No. 8...	The Results of Experiments Showing the Effect of Various Fertilizers on the Growth of Corn, Oats, Wheat, and Grass.
July	Bulletin No. 9...	The Results of Experiments Showing the Effect of Various Fertilizers on the Growth of Corn, Oats, and Wheat.
	Annual Report..	Annual Report, 1884.
1885.		
January ...	Bulletin No. 10..	Feeding Experiments.
July.......	Bulletin No. 11..	Experiments with Fertilizers, 1884.
	Annual Report .	Annual Report, 1885.
1886.		
January ...	Bulletin No. 12..	Feeding Experiments.
February ..	Bulletin No. 13..	Course in Mechanic Arts.
June	Bulletin No. 14..	The Grass Crops of 1885.
October....	Bulletin No. 15..	The Composition of Soiling Rye.
November .	Bulletin No. 16..	The Composition and Food Value of Desiccated Apple Pomace.
	Annual Report..	Annual Report, 1886.
1887.		
October....	Bulletin No. 1 ..	Historical Sketch of the Agricultural Experiments Conducted by the Pennsylvania State College, 1857-87; Studies upon the Composition and Development of Soiling Crops.
	Annual Report .	Annual Report for 1887.
1888.		
January ...	Bulletin No. 2 ..	Field Experiments with Phosphates.
April	Bulletin No. 3 ..	Composition and Digestibility of Corn Stover.
July	Bulletin No. 4 ..	Seed Germinations
October....	Bulletin No. 5 ..	The Digestibility of Soiling Rye.
	Annual Report .	Annual Report for 1888.
1889.		
January ...	Bulletin No. 6 ..	Tests of Varieties: Wheat, Oats, Barley, Potatoes, Forage Crops, etc.
April	Bulletin No. 7 ..	Tests of Varieties of Field Corn; Analyses and Valuation of Fertilizers.

* The bulletins and reports for 1869 to 1886, inclusive, were issued by the Pennsylvania State College.

List of station publications issued prior to January 1, 1892—Continued.

PENNSYLVANIA STATION—Continued.

Date.	Publication.	Title.
1889.		
July	Bulletin No. 8	Testing New Varieties; Germination Tests.
October	Bulletin No. 9	Digestibility of Corn Fodder and Silage.
	Annual Report	Annual Report for 1889.
1890.		
January	Bulletin No. 10	Should Farmers Raise Their Own Vegetable Seeds? Notes on New Varieties of Vegetables; Tests of Agricultural Varieties.
April	Bulletin No. 11	Indian Corn as a Grain and Forage Crop.
July	Bulletin No. 12	Simple Methods of Determining Milk Fat; Dried Brewers' Grains.
October	Bulletin No. 13	Black Knot on Plums; A Few Ornamental Plants.
	Annual Report	Annual Report for 1890.
1891.		
January	Bulletin No. 14	Tests of Varieties of Vegetables for 1890.
April	Bulletin No. 15	Influence of Variety and of Rate of Seeding on the Yield of Ensilage Corn.
July	Bulletin No. 16	Culture of the Chestnut for Fruit.
October	Bulletin No. 17	The Value of Cotton-Seed Meal as Compared with Bran for the Production of Butter.

RHODE ISLAND STATION.

Date.	Publication.	Title.
1888.		
	Annual Report	First Annual Report, 1888.
1889.		
March	Bulletin No. 1	Organization.
June	Bulletin No. 2	The Farm, Historical, Physical, and Geological Description.
September	Bulletin No. 3	Stock Feeding.
December	Bulletin No. 4	Bee Keeping, Establishment of the Apiary.
December	Bulletin No. 5	Potatoes.
	Annual Report	Second Annual Report, 1889.
1890.		
March	Bulletin No. 6	Milk Fever or Parturient Apoplexy in Cows.
June	Bulletin No. 7	Catalogue of Fruits; Meteorological Summary; Spring Report of the Apiarist.
September	Bulletin No. 8	Soils and Fertilizers.
December	Bulletin No. 9	Experiments in Apiculture.
	Annual Report	Third Annual Report, 1890.
1891.		
May	Bulletin No. 10	Mixed Foods in Cases of Faulty Appetite in Horses and Neat Stock; Patented and Proprietary Foods; Sore Shoulders in Horses.
June	Bulletin No. 11	The State Fertilizer Law as it Is and as it Might Be; Commercial Value of Fertilizer Stock; Analyses of Commercial Fertilizers; State Inspection, 1891; Analyses of Miscellaneous Materials Sent on for Examination; Meteorological Summary.
August	Bulletin No. 12	Further Analyses of Commercial Fertilizers Collected under the State Inspection, 1891, with Comments.
September	Bulletin No. 13	Fertilizers.
October	Bulletin No. 14	Potato Scab; The Bordeaux Mixture as a Preventive of Potato Scab and Potato Blight; Transplanting Onions.

SOUTH CAROLINA STATION.

Date.	Publication.	Title.
1883–86.		
	....	Reports of the Work of the Experimental Farm of the South Carolina College
1888.		
April	Bulletin No. 1	Tests of Varieties of Cotton.
May	Bulletin No. 2	Tests of Commercial Seeds.
July	Bulletin No. 3	Analyses of Fertilizers and Feeding Stuffs.
	Annual Report	First Annual Report, 1888.
1889.		
January	Bulletin No. 4	Entomology.
April	Bulletin No. 5	Oats and Wheat.
July	Bulletin No. 6	Hog Cholera.
October	Bulletin No. 7	Meteorological Data.
	Annual Report	Second Annual Report, 1889.
1890.		
March	Bulletin No. 8	Chemical Composition of Corn Silage, Cowpeas, and Soja Beans in South Carolina.
	Annual Report	Third Annual Report, 1889-90.
	NEW SERIES.	
1891.		
July	Bulletin No. 1	Table of Analyses of Commercial Fertilizers.

List of station publications issued prior to January 1, 1892—**Continued.**

SOUTH CAROLINA STATION—Continued.

Date.	Publication.	Title.
1891.		
July	Bulletin No. 2	Cotton, Experiments with Varieties and with Fertilizers.
October	Bulletin No. 3	Analyses of Commercial Fertilizers.
December	Bulletin No. 4	Fertilizer Tests with Wheat; Varieties of Wheat and Oats.
	Annual Report	Fourth Annual Report, 1891.

SOUTH DAKOTA STATION.

1887.		
November	Bulletin No. 1	Notes on the Growth of Trees in the College Grounds.
1888.		
April	Bulletin No. 2	Organization; Growth of Grains Tabulated; Potatoes; Clover.
April	Bulletin No. 3	Arbor Day—Why to Plant, What to Plant, How to Plant.
July	Bulletin No. 4	Reports of Departments of Agriculture, Forestry, Horticulture, and Entomology.
October	Bulletin No. 5	Garden Notes, with Table of Meteorological Observations.
December	Bulletin No. 6	Garden Notes and Other Field Observations; Meteorological Tables.
December	Bulletin No. 7	Notes on Small Fruits; The Orchard and Ornamental Plants.
December	Bulletin No. 8	The Drinking Waters of Dakota.
	Annual Report	First Annual Report, 1888.
1889.		
January	Bulletin No. 9	Corn.
February	Bulletin No. 10	The Germination of Frosted Grain.
March	Bulletin No. 11	Small Grain.
April	Bulletin No. 12	Forestry, Horticulture, and Botany.
April	Bulletin No. 13	Entomology.
April	Bulletin No. 14	The Sugar Beet.
November	Bulletin No. 15	Forestry.
	Annual Report	Second Annual Report, 1889.
1890.		
February	Bulletin No. 16	The Sugar Beet.
March	Bulletin No. 17	Small Grain.
March	Bulletin No. 18	Cutworms.
December	Bulletin No. 19	The Sugar Beet.
	Annual Report	Third Annual Report, 1890.
1891.		
January	Bulletin No. 20	Forestry.
February	Bulletin No. 21	Experiments with Small Grains.
March	Bulletin No. 22	Injurious Insects.
April	Bulletin No. 23	Forest Trees, Fruits, and Vegetables.
May	Bulletin No. 24	Corn.
June	Bulletin No. 25	Glanders.
July	Bulletin No. 26	Strawberries, the Sand Cherry, and Orchard Notes.
November	Bulletin No. 27	The Sugar Beet in South Dakota.
December	Bulletin No. 28	Irrigation.
December	Bulletin No. 29	Forestry and Fungi.
	Annual Report	Fourth Annual Report, 1890-91.

TENNESSEE STATION.

1882.	Report*	Experiments in Wheat Culture and Other Crops.
1884.	Bulletin No. 1*	Analyses and Tests of Manures and Fertilizers for 1883-84.
1885-86.	Report*	Wheat Culture and Forage Crops.
1888.		
April	Bulletin Vol. I, No. 1.	History and Reorganization; Dehorning Cattle.
July	Bulletin Vol. I, No. 2.	The Experiment Station; Building and Laboratories; Germination of Seed Corn; Analyses of Commercial Fertilizers.
October	Bulletin Vol. I, No. 3.	Weeds of the Farm.
	Annual Report	First Annual Report, 1888.
1889.		
January	Bulletin Vol. II, No. 1.	Notes on Fertilizers and Fertilizing Materials.
April	Bulletin Vol. II, No. 2.	Diseases of the Irish Potato.
July	Bulletin Vol. II, No. 3.	Cotton-Seed Hulls and Meal as Food for Live Stock.

* Report of work in the Agricultural Department and the University of Tennessee.

List of station publications issued prior to January 1, 1892—**Continued.**

TENNESSEE STATION—Continued.

Date.	Publication.	Title.
1889.		
October ...	Bulletin Vol. II, No. 4.	Grasses of Mountain Meadows and Deer Parks; Chemical Composition and Tests of Varieties of Strawberries.
September.	Spec. Bulletin A.	The Army Worm, How to Prevent its Ravages on Cotton.
October....	Spec. Bulletin B.	Analyses of Commercial Fertilizers.
	Annual Report .	Second Annual Report, 1889.
1890.		
January ...	Bulletin Vol. III, No. 1.	Experiments in Growing Potatoes.
April	Bulletin Vol. III, No. 2.	Field Experiments with Barley, Corn, Oats, Wheat, Sorghum, and Clover.
July	Bulletin Vol. III, No. 3.	Points about Country Roads.
May	Special Bulletin C.	The Treatment of Certain Fungous Diseases of Plants.
July	Special Bulletin D.	Potash and Paying Crops.
July	Special Bulletin E.	The Cotton Worm; The Hessian Fly.
October....	Bulletin Vol. III, No. 4.	Practical Experiments in Reclaiming "Galled" or Washed Lands; Notes on Mulch and Mulch Materials.
December..	Bulletin Vol. III, No. 5.	Fruit Trees at the Experiment Station.
December..	Bulletin Vol. III, No. 6.	Index to Vols. I and II.
1891.		
January ...	Bulletin Vol. IV, No. 1.	Crab Grass Hay; Sorghum as a Forage Plant; Test of Feed Value of First and Second Crops of Clover; Pasture Grasses; Black Knot of the Plum and Cherry; Pruning Fruit Trees; The Glassy Winged Soldier Bug; Diseases of Live Stock; Experiment Station Record.
April	Bulletin Vol. IV, No. 2.	The Peanut Crop of Tennessee, Statistics, Culture, and Chemistry.
July	Bulletin Vol. IV, No. 3.	The True Bugs or Heteroptera of Tennessee.
October....	Bulletin Vol. IV, No. 4.	Some Fungous Diseases of the Grape.
December..	Bulletin Vol. IV, No. 5.	A Chemical Study of the Cotton Plant.

TEXAS STATION.

1883.		
November .	Bulletin No. 1*..	Preliminary.
1884.		
June.......	Bulletin No. 2*..	Notes and Experiments.
1885.		
June.......	Bulletin No. 3*..	Notes and Experiments.
1886.		
June.......	Bulletin No. 4*..	Acclimating Cattle.
1887.		
December..	Bulletin No. 5*..	Tests of Value of Different Fertilizers.
1888.		
	Bulletin No. 1...	Plan of Organization.
May	Bulletin No. 2...	Experiments in Cattle Feeding; Analyses of Fertilizers and Ores; Horticultural Department; Meteorological Department.
October....	Bulletin No. 3...	Grasses and Other Forage Plants.
December..	Bulletin No. 4...	Root Rot of Cotton or "Cotton Blight."
	Annual Report .	First Annual Report, 1888.
1889.		
March	Bulletin No. 5...	Creameries in Texas.
June.......	Bulletin No. 6...	Feeding Experiment.
November .	Bulletin No. 7...	Cotton Root Rot.
December..	Bulletin No. 8...	Work in Horticulture.
	Annual Report .	Second Annual Report, 1889.
1890.		
May	Bulletin No. 9...	Pear Stocks; Some Parasitic Fungi of Texas.
May	Bulletin No. 10..	Feeding Experiment.
August	Bulletin No. 11..	Effect of Cotton Seed and Cotton-Seed Meal on Butter; Quality of Butter from Sweet and Sour Cream.
September.	Bulletin No. 12..	The Screw Worm.
December..	Bulletin No. 13..	Sorghum; Teosinte.
	Annual Report .	Third Annual Report, 1890.
1891.		
March	Bulletin No. 14..	Effect of Cotton Seed and Cotton-Seed Meal in the Dairy Ration on Gravity and Centrifugal Creaming of Milk.
May	Bulletin No. 15..	Influence of Climate on the Composition of Corn; Digestibility of Food Stuffs; Miscellaneous Analyses.

*Bulletins of the Agricultural and Mechanical College.

List of station publications issued prior to January 1, 1892—**Continued.**

TEXAS STATION—Continued.

Date.	Publication.	Title.
1890.		
June	Bulletin No. 16	Drainage Experiments; Irish Potatoes; Cabbage; Strawberries; Russian Fruits and Ornamental Trees; Lists of Fruits on Trial; Forest Trees Successful to Date.
August	Bulletin No. 17	General Information Relating to the Texas Agricultural Experiment Station.
October	Bulletin No. 18	Liver Flukes.
December	Bulletin No. 19	Corn Fodder.
	Annual Report	Fourth Annual Report, 1891.

UTAH STATION.

Date.	Publication.	Title.
1890.		
June	Bulletin No. 1	Investigations in Progress at the Station.
November	Bulletin No. 2	Plow Trials.
	Annual Report	First Annual Report, 1890.
1891.		
January	Bulletin No. 3	Experiments with Garden Vegetables.
	Bulletin No. 4	Dynamometer Tests with Wagons.
March	Bulletin No. 5	Potato Trials.
May	Bulletin No. 6	Trials of Sleds and Tillage Tools.
July	Bulletin No. 7	Draft of Mowing Machines.
August	Bulletin No. 8	Ensilage.
	Bulletin No. 9	Time of Watering Horses; Whole *vs.* Ground Grain for Horses.
December	Bulletin No. 10	Experiments with Strawberries, Peas, and Beans.
	Annual Report	Second Annual Report, 1891.

VERMONT STATION.

Date.	Publication.	Title.
1887.		
March	Bulletin No. 1	Analysis of Fertilizers.
June	Bulletin No. 2	Analysis of Fertilizers.
August	Bulletin No. 3	Analyses of Bone Meal.
November	Bulletin No. 4	Experiments with New Fodder Plants.
	Annual Report	First Annual Report, 1887.
1888.		
January	Bulletin No. 5	Analyses of Fertilizers.
February	Bulletin No. 6	Analyses of Fertilizers.
March	Bulletin No. 7	Conference on Acceptance of the Hatch Act.
April	Bulletin No. 8	Analyses of Fertilizers.
April	Bulletin No. 9	Smut in Oats, Insecticides, and Fertilizer Analyses.
May	Bulletin No. 10	New Organization.
June	Bulletin No. 11	Coöperation in the Study of Insects.
August	Bulletin No. 12	Insecticides. Seed Tests. Miscellaneous Analyses.
November	Bulletin No. 13	Methods of Cutting and Planting Potatoes; Fertilizer Analyses.
	Annual Report	Second Annual Report, 1888.
1889.		
March	Bulletin No. 14	Analyses of Fertilizers.
June	Bulletin No. 15	Effect of Fertilizers on the Composition of Corn; Analysis of Hay.
July	Bulletin No. 16	Testing Milk at Creameries.
October	Bulletin No. 17	Test of Dairy Cows.
	Annual Report	Third Annual Report, 1889.
1890.		
January	Bulletin No. 18	Pig Feeding.
April	Bulletin No. 19	Questions Concerning Injurious Insects.
May	Bulletin No. 20	Fertilizer Analysis.
September	Bulletin No. 21	A New Milk Test; Testing Milk at Creameries and Cheese Factories; Notes for the Laboratory.
October	Bulletin No. 22	Test of Dairy Cows; Home *vs.* Fair Grounds.
	Annual Report	Fourth Annual Report, 1890.
1891.		
March	Bulletin No. 23	Fertilizers.
May	Bulletin No. 24	Potato Blight and Rot.
June	Bulletin No. 25	The Bounty on Maple Sugar.
September	Bulletin No. 26	Maple Sugar.

VIRGINIA STATION.

Date.	Publication.	Title.
1889.		
	Bulletin No. 1	Application of Fertilizers to Wheat.
October	Bulletin No. 2	Experiment Orchard; Small Fruits.
November	Bulletin No. 3	Steer Feeding; Meteorological Record.

List of station publications issued prior to January 1, 1892—**Continued.**

VIRGINIA STATION—Continued.

Date.	Publication.	Title.
1890.		
January	Bulletin No. 4	Tomatoes.
March	Bulletin No. 5	Notes on Feeding Stuffs.
March	Bulletin No. 6	Variety Tests with Potatoes.
July	Bulletin No. 7	Variety Tests with Strawberries.
	Annual Report	Annual Report, 1889-90.
1891.		
January	Bulletin No. 8	Potato Tests.
February	Bulletin No. 9	Tomatoes.
June	Bulletin No. 10	Steer and Pig Feeding.
October	Bulletin No. 11	Vegetables.
	Annual Report	Annual Report, 1890-91.

WASHINGTON STATION.

1891.		
December	Bulletin No. 1	Announcements.

WEST VIRGINIA STATION.

1888.		
July	Bulletin No. 1	Organization and Work of Station.
October	Bulletin No. 2	The History, Properties, Source of the Ingredients, Mode of Application, and Uses of Commercial Fertilizers.
December	Bulletin No. 3	Birds of West Virginia.
	Annual Report	First Annual Report, 1887-88.
1889.		
March	Bulletin No. 4	The Creamery Industry, Its Adaptability to West Virginia.
June	Bulletin No. 5	The Selection of Milch Cows.
	Bulletin No. 6	Six Months' Experience in Running a Creamery; Improved Process of Handling Cream and Churning.
	Annual Report	Second Annual Report, 1889.
1890.		
	Bulletin No. 7	Experiments upon Wheat, Fruit Trees, Garden Seeds, Grasses, Forage Crops, and Miscellaneous Subjects.
June	Bulletin No. 8	Summary of Meteorological Observations and Reports of Correspondents on Condition of Agriculture.
July	Bulletin No. 9	Additional Reports upon Wheat Distributed in 1889; Meteorological Report for July; Reports of Correspondents upon Meteorology and Crops for July.
August	Bulletin No. 10	Meteorological Report for August; Reports of Correspondents upon Meteorology and Crops for August.
	Special Bulletin	Potash and Paying Crops.
September	Bulletin No. 11	Meteorology and Reports on Condition of Crops.
December	Bulletin No. 12	The Canada Thistle.
	Annual Report	Third Annual Report, 1890.
1891.		
January	Bulletin No. 13	The Creamery Industry.
February	Bulletin No. 14	Farm and Garden Insects; Notes of the Season.
March	Bulletin No. 15	Raspberry Gouty-Gall Beetle.
April	Bulletin No. 16	Forest and Shade-Tree Insects; Yellow Locusts.
May	Bulletin No. 17	Forest and Shade-Tree Insects; Black Spruce.
September	Bulletin No. 18	Commercial Fertilizers.
November	Bulletin No. 19	Your Weeds and Your Neighbors.

WISCONSIN STATION.

1883.		
August	Bulletin No. 1	Sweet Skim Milk, Its Value as Food for Pigs and Calves.
	Annual Report	First Annual Report, 1883.
1884.		
April	Bulletin No. 2	Amount and Condition of Seed Corn in Wisconsin.
June	Bulletin No. 3	Composition and Digestibility of Fodders.
September	Bulletin No. 4	Experiments on Milk Production.
	Annual Report	Second Annual Report, 1884.
1885.		
April	Bulletin No. 5	Analyses of Feeding Stuffs.
July	Bulletin No. 6	Experiments on Calf Feeding; Analyses of Fertilizers.
October	Bulletin No. 7	Experiments on Calf Feeding; the Cooley System of Creaming Milk.
December	Bulletin No. 8	Oil Meal *vs.* Corn Meal for Milk.
	Annual Report	Third Annual Report, 1885.

List of station publications issued prior to January 1, 1892—**Continued.**

WISCONSIN STATION—Continued.

Date.	Publication.	Title.
1886.		
March	Bulletin No. 9	Report on Oats, Potatoes, and Corn for 1885.
October	Bulletin No. 10	Tests of Dairy Cows.
	Annual Report	Fourth Annual Report, 1886.
1887.		
April	Bulletin No. 11	Report on Wheat, Oats, Barley, Potatoes, and Corn for 1886.
October	Bulletin No. 12	The Oil Test for Cream.
1888.		
February	Bulletin No. 13	Report on Wheat, Oats, Barley, Corn, and Potatoes for 1887; The Station Vineyard.
April	Bulletin No. 14	Artificial Fertilizers and Land Plaster.
May	Bulletin No. 15	Ensilage *vs.* Corn Fodder for Milk Production.
July	Bulletin No. 16	A New Method for Determining Fat in Milk.
November	Bulletin No. 17	Report on Corn, Oats, Barley, and Potatoes; Grape Growing.
	Annual Report	Fifth Annual Report, 1888.
1889.		
January	Bulletin No. 18	The Constitution of Milk and Some of the Conditions which Affect the Separation of Cream.
April	Bulletin No. 19	Notes on Ensilage.
July	Bulletin No. 20	Noxious Weeds of Wisconsin.
October	Bulletin No. 21	Comparative Value of Warm and Cold Water for Milch Cows in Winter.
	Annual Report	Sixth Annual Report, 1889.
1890.		
January	Bulletin No. 22	Oats and Barley; Potatoes.
April	Bulletin No. 23	Prevention of Apple Scab.
July	Bulletin No. 24	A new method for the Estimation of Fat in Milk, Especially Adapted to Creameries and Cheese Factories.
October	Bulletin No. 25	Feeding Bone Meal and Hard-Wood Ashes to Hogs Living on Corn.
	Annual Report	Seventh Annual Report, 1890.
1891.		
January	Bulletin No. 26	Sugar-Beet Culture in Wisconsin.
April	Bulletin No. 27	The Feeding Value of Whey.
July	Bulletin No. 28	The Construction of Silos.
October	Bulletin No. 29	Creaming Experiments.
	Annual Report	Eighth Annual Report, 1891.

WYOMING STATION.

1891.		
May	Bulletin No. 1	The Organization and Proposed Work of the Station.
August	Bulletin No. 2	Plant Lice.
November	Bulletin No. 3	The Sugar Beet in Wyoming.
December	Bulletin No. 4	Meteorology for 1891.
	Annual Report	Annual Report, 1891.

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U. S. DEPARTMENT OF AGRICULTURE

OFFICE OF EXPERIMENT STATIONS

A. W. HARRIS, DIRECTOR

EXPERIMENT STATION

RECORD

VOL. III, NO. 11

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GOVERNMENT PRINTING OFFICE

1892

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Each station issues bulletins and annual reports, which are sent free of charge to citizens of its own State, and, so far as practicable, to applicants from other States. The work of the stations is also summarized in publications of this Office.

The Office of Experiment Stations issues two classes of publications for general distribution:

(1) Farmers' Bulletins, which are brief and popular in character, and are sent on application.

(2) Experiment Station Bulletins, Miscellaneous Bulletins, and the Experiment Station Record, which are more or less technical. It is the practice to send to persons applying for them one or more numbers, from which they may judge of their usefulness, but not to place any names upon the mailing list until after receipt of applications on special blanks furnished by the Office.

The following bulletins have been issued:

Farmers' Bulletins.—No. 1, The What and Why of Agricultural Experiment Stations; No. 2, Illustrations of the Work of the Stations.

Experiment Station Bulletins.—No. 1, Organization and History of the Stations; No. 2, Digest of Annual Reports of the Stations for 1888, in two parts; No. 3, Report of Meeting of Horticulturists at Columbus, Ohio, June, 1889; No. 4, List of Station Horticulturists and Outline of their Work; No. 5, Organization Lists of Stations and Colleges, March, 1890; No. 6, List of Station Botanists and Outline of their Work; No. 7, Proceedings of the Fifth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, Washington, D. C., August, 1891; No. 10, Meteorological Work for Agricultural Institutions.

Miscellaneous Bulletins.—No. 1, Proceedings of Knoxville Convention of Association of Agricultural Colleges and Stations, January, 1889; No. 2, Proceedings of Washington Convention of the Association, November, 1889; No. 3, Proceedings of Champaign Convention of the Association, November, 1890.

The Experiment Station Record, vol. I, 6 numbers; vol. II, 12 numbers; vol. III, Nos. 1–10. Copies of the station and Department publications abstracted in the Record can, in many instances, be obtained on application.

Communications intended for this Office should be addressed to the SECRETARY OF AGRICULTURE, for the *Office of Experiment Stations, Department of Agriculture, Washington, D. C.*